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Final Report

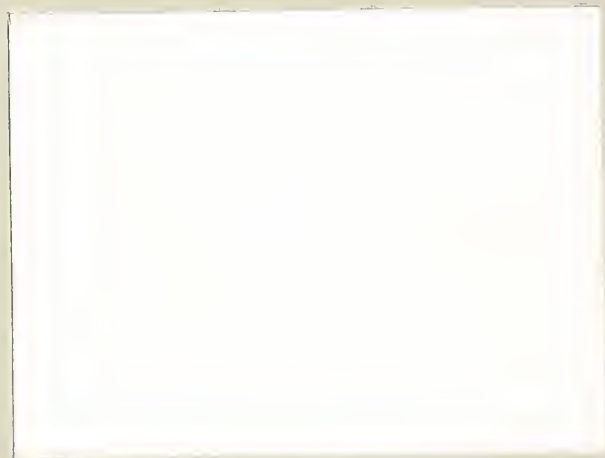
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COST REDUCTION AND INCREASED
EFFICACY OF GROWTH RETARDANT
MIXTURES FOR VEGETATION MANAGE-
MENT ALONG INDIANA ROADSIDES

D. James Morre



PURDUE UNIVERSITY



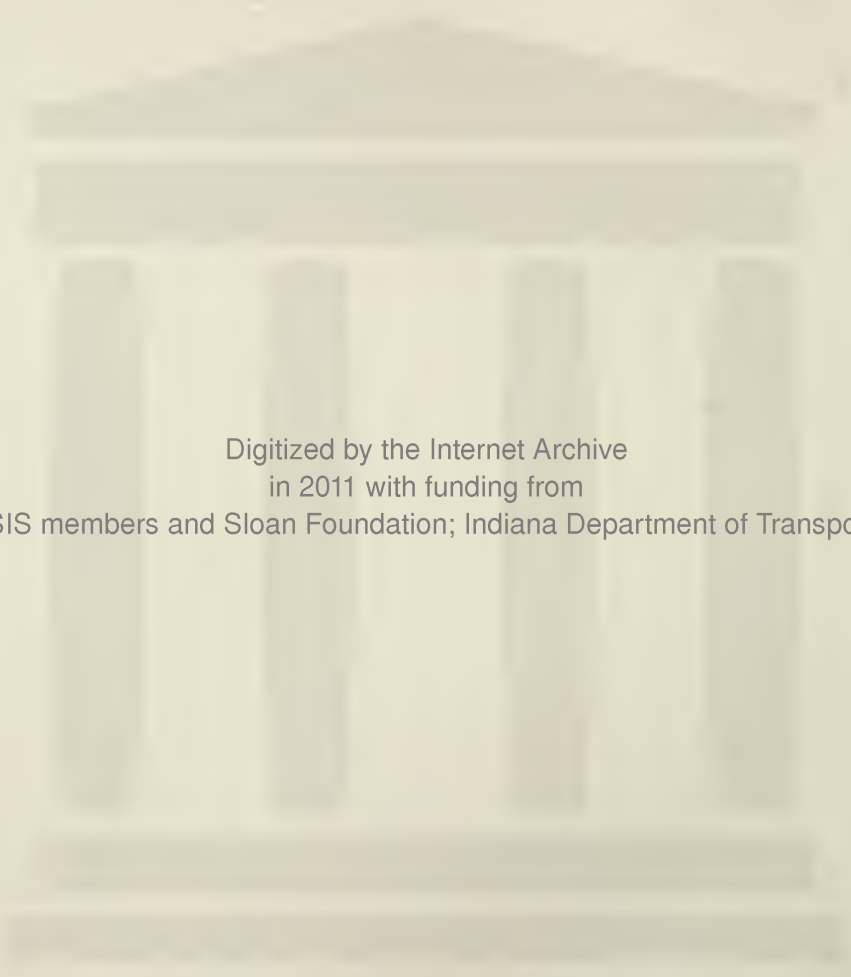
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COST REDUCTION AND INCREASED EFFICACY OF GROWTH RETARDANT MIXTURES FOR VEGETATION MANAGEMENT ALONG INDIANA ROADSIDES

TO: H. L. Michael, Director
Joint Highway Research Project

December 31, 1987

Project: C-36-53K

FROM: D. J. Morré

File: 9-5-11

Attached is a Final Report of the HPR Part II study titled "Cost Reduction and Increased Efficacy of Growth Retardant Mixtures for Vegetation Management Along Indiana Roadsides." I served as the Principal Investigator on this study, directed the project and have authored the report.

The research results include recommendations for a single spray application that will control weeds, retard grass growth and prevent formation of seedheads in bluegrass and fescue. For control of both bluegrass and fescue, no further herbicide applications or mechanical mowings are required for the year of treatment. The recommendations are based on new combinations of materials developed under the project where cost-effectiveness has been increased to the point that the cost of the spray application is competitive with a single mechanical mowing cycle.

In early stages of implementation evaluation is a combination of materials developed specifically for use on secondary and narrow right-of-way highways. It includes materials effective in suppression of seed heads in smooth brome and late-germinating annual grasses such as foxtails and barn-yard grass that invade from adjacent agricultural lands. Failure to control both these types of grass have in the past have largely limited chemical mowing to the Interstate System. Removal of this limitation is expected to increase greatly potential cost savings from substantial reductions in force-account mowings and reduced necessity for purchase of costly mowing equipment.

The results of these studies have been recommended for implementation in the State of Indiana and plans to begin the implementation phase have been initiated. These and other findings with potential for further development are expected to point the way to even greater cost saving modifications in the program of chemical mowing for future years.

Sincerely

D. James Morré
D. James Morré

1. Report No. FHWA/IN/JHRP-88/2	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Cost Reduction and Increased Efficacy of Growth Retardant Mixtures for Vegetation Management Along Indiana Roadsides		5. Report Date December 31, 1987	
		6. Performing Organization Code	
7. Author(s) D. James Morre		8. Performing Organization Report No. JHRP-88/2	
9. Performing Organization Name and Address Joint Highway Research Project Civil Engineering Building Purdue University West Lafayette, Indiana 47907		10. Work Unit No.	
		11. Contract or Grant No. HPR-Part II	
12. Sponsoring Agency Name and Address Indiana Department of Highways State Office Building 100 North Senate Avenue Indianapolis, Indiana 46204		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.			
16. Abstract A cost-effective program of chemical mowing for use on Indiana roadsides has been developed. A single spring application of a combination of new materials gives season-long control of seedheads in bluegrass and fescue as well as control of broad-leaf weeds and suppression of grass growth. The cost of materials and application are equal to or less than the cost of a single mowing cycle. The treatment is environmentally safe when applied in early spring before most agricultural crops have been planted. Problems of carry over with repeated applications to the same area have been reduced or eliminated by low overall application rates recommended. The effectiveness and low cost of the combination is based on the ability of certain growth regulatory materials, referred to as additives, that may be only weakly effective as growth retardants themselves, to interact in a synergistic fashion with mefluidide to increase overall efficacy and to reduce the required application rates sufficiently to make chemical mowing an economically sound practice. The combination has been field tested for five years under actual use conditions, and was found to be effective for full season management of mixed bluegrass-tall fescue turf to permit considerable cost savings when compared to 2-cycle or 3-cycle mechanical mowing. On secondary and narrow right-of-way roadsides, seedheads from smooth brome and from later-germinating annual grasses such as foxtails and barnyard grass cause additional problems. For use on such roads, a new combination has been developed that includes trichlopyr (Garlon) plus an agent for pre-emergence control of annual grasses. Implementation is expected to increase potential cost-savings even further through reductions in force-account mowing and in reduced necessity to purchase costly mowing equipment.			
17. Key Words chemical mowing, roadsides, growth retardation, growth regulator, herbicide, maintenance		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 137	22. Price

Final Report

COST REDUCTION AND INCREASED EFFICACY OF GROWTH RETARDANT MIXTURES FOR
VEGETATION MANAGEMENT ALONG INDIANA ROADSIDES

by

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Joint Highway Research Project

Project No. C-36-53K

File No: 9-5-11

Prepared as Part of an Investigation

Conducted by the

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana Department of Highways

and the

U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

Purdue University
West Lafayette, Indiana

December 31, 1987

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Abstract. A cost-effective program of chemical mowing for use on Indiana roadsides has been developed. A single spring application of a combination of new materials gives season-long control of seedheads in bluegrass and fescue as well as control of broad-leaf weeds and suppression of grass growth. The combination includes a primary growth retardant, mefluidide [Embark], a synergistic additive, chlorsulfuron [Telar or Glean], a detergent to enhance penetration [X-77 or equivalent] and a herbicide, 2,4-D. The costs of materials and application are equal to or less than the cost of a single mowing cycle. The treatment is environmentally safe when applied in early spring before most agricultural crops have been planted. Problems of carry over with repeated applications to the same area have been reduced or eliminated by low overall application rates recommended. The effectiveness and low cost of the combination is based on the ability of certain growth regulatory materials, referred to as additives, that may be only weakly effective as growth retardants themselves, to interact in a synergistic fashion with mefluidide to increase overall efficacy and to reduce the required application rates sufficiently to make chemical mowing an economically sound practice. The Embark-Telar-Surfactant-2,4-D combination detailed above has been field tested for five years under actual use conditions, and was found to be effective for full season management of mixed bluegrass-tall fescue turf to permit considerable cost savings when compared to 2-cycle or 3-cycle mechanical mowing. On secondary and narrow right-of-way roadsides, seed heads from smooth brome and from later-germinating annual grasses such as foxtails and barnyard grass cause additional problems. For use on such roads, a new combination has been developed that includes trichlopyr [Garlon] plus an agent for pre-emergence control of annual grasses. Implementation is expected to increase potential cost-savings even further through reductions in force-account mowing and in reduced necessity to purchase costly mowing equipment.

Introduction

Mechanical mowing of roadsides as required to meet current safety and esthetic standards is a substantial budget item in any program of roadside maintenance. At current costs of \$20-25 per acre per mowing cycle, 3 cycle mowing to maintain adequate site distances and visual appearances would cost between \$60 and \$75 per acre annually. In Indiana, where approximately 70,000 acres of roadside are mowed each year, the annual costs may well exceed \$5,000,000. The present program of chemical mowing detailed by this report, if implemented, is expected to reduce present mowing costs by 50% or more.

The research described was initiated with a view to develop a growth retardant mixture that would reduce or prevent the formation of grass seed heads and control tall weeds so that the need for mechanical mowing along roadsides could be eliminated or reduced. The treatment was to consist of a single spray application, was to be effective against both fescue and bluegrass as well as give control of broadleaf weeds and brush. Maximum grass height was not to exceed acceptable mowing limits at any time during the growing season. In addition, the treatment was to have been safe for the environment. There was to be no permanent weakening of the root system of established turf, no injury to desirable species and no carry over that would limit repeated use on an annual basis. A healthy lawn-type appearance to the turf was a desirable characteristic. The cost should be sufficiently low to make the treatment competitive at least with 3-cycle mechanical mowing. The requirement to prevent emergence of seedheads in fescue, however, was the most important. If even a few seed heads of normal height are formed by the fescue, the appearance of the roadside will be unsightly, such that the elimination of such seedheads was an essential requirement.

The approach followed was to first identify the most cost-effective primary growth retardant available for elimination of seedheads in fescue and then to employ various additives in different combinations to simultaneously increase efficacy and reduce treatment costs. 2,4-D, amine salt, was included for control of both broadleaf weeds and of brush species. The research program undertaken combined laboratory and greenhouse studies with field investigations. Growth retardant combinations, once identified, were perfected and modified on the basis of greenhouse as well as laboratory studies and then verified in the field. Field studies involved both large and small plots as well as large-scale tests under actual use conditions using truck-mounted equipment in collaboration with District highway personnel. Close liaison was maintained with both State and District highway personnel both in the planning and evaluation of new combinations and in determining the most effective implementation strategies.

The following report represents a summary of findings important to the development of the recommendations made. Field results from 1983-1984 were the subject of an Interim Report (Joint Highway Research Project Interim Report, FHWA/IN/JHRP-85/1 "EMBARK-TELAR-SURFACTANT-2,4-D COMBINATIONS FOR VEGETATION MANAGEMENT ALONG INDIANA ROADSIDES") published in 1985. These findings together with additional laboratory, greenhouse and implementation tests in the field during 1985 were summarized in 1986 (Morré, D. J. and K. Tautvydas. 1986. Mefluidide-chlorsulfuron-2,4-D-surfactant combinations for roadside vegetation management. J. Plant Growth Regulation 4:189-201), the essential features of which are repeated here. Many of the detailed experimental findings from 1986 and 1987, hitherto unpublished and unreported, are included with this report as Appendix I and Appendix II, respectively. Important findings are summarized within the narrative portion of the report.

Materials and Methods

Field trials

All of the field tests were under roadside conditions. Large scale tests were applied in Miami county Indiana in 1983 using truck-mounted equipment provided by commercial applicators contracted by the State of Indiana and coordinated by Mr. John Burkhardt, Indiana Department of Highways. In 1984, 1985, 1986 and 1987 segments of I-70 between Indianapolis and the Illinois State Line were treated also using truck mounted equipment. Applications were at 25 gpa using a Swinglok applicator system under the supervision of Mr. Don Bickle of the Crawfordsville District. Also in 1985, 1986 and 1987 additional tests were conducted in the Crawfordsville District on US 231 and US 136 north and east of Crawfordsville. Again, Swinglok equipment was used. The latter were on 1 mile (about 2 1/2 acre) plots.

All other field tests were in Tippecanoe County, Indiana. Applications were with a hand held compressed air sprayer, Spraying Systems 8004 nozzles, 40 psi and 40 gpa. Plots were located either adjacent to the pavement or adjacent to the fence in mixed stands of fescue and bluegrass unless indicated otherwise (e.g. mixed stands containing smooth brome or orchardgrass). Except for fall applications, all grass was unmowed at the time of application. Plots were 3 ft X 6 ft or 6 ft X 15 ft in triplicate except for fall applications with pure bluegrass turf where a small plot size was utilized. Seedheads were counted in 3 1 ft squares in 3 different regions in each plot and averaged. Results are averages of the results of the three different replications plus or minus the standard deviation from the mean determined statistically. Seedhead height was an average of "maximum" seedhead height in 3 different areas of each plot and is expressed in inches. Blade height is the maximum extended blade height (soil to tip) in inches of the lower blades originating at the base of

the grass clump from 3 different areas of each plot. As with seedhead numbers per ft², seedhead heights and blade heights are averages of the results of the three different replicates plus or minus the standard deviation from the mean determined statistically.

Broad-leaf weeds were counted from the entire plot or within 10 10 ft² rectangles for plots exceeding 100 ft² in area. Individual weed species were recorded individually and then totaled to determine total weeds.

Greenhouse studies

Seeds of Kentucky bluegrass, var. Parade were germinated over a mixture of caclined clay and pasteurized soil contained in 524 ml polystyrene cups with perforated bottoms and covered with a thin layer of vermiculite. Watering and fertilizer feeding were done by bottom irrigation. Treatments were applied 3 weeks after seeding using a Beltsville-type sprayer equipped with a TX-6 TeeJet nozzle operated at 40 psi with the conveyor belt moving at 0.5 mph (555.6 l/ha).

Alternatively, established bluegrass sod was purchased locally from a nursery and transferred to 4 or 6 inch clay pots. Grass was grown for 2 to 3 weeks to permit re-establishment and mowed to a uniform height of 2 inches prior to spraying. Pots were sprayed individually using a atomizer and a premeasured volume of solution equivalent to either 40 or 80 gpa.

Approximately 7 days after treatment, the grass heights were measured to the nearest 0.5 inch with a ruler and the grass was again cut to an initial height of 2 inches above the soil level. The clippings were weighed to the nearest 0.1 g. Two weeks later, regrowth was again determined both from direct measurement and/or from clipping weights. Each treatment was replicated from 3 to 5 times. Data were analyzed statistically.

Laboratory studies

Initially, laboratory studies employed a number of different assays to evaluate effectiveness of different plant growth regulator molecules, to search for new sources of plant growth regulator activity and to investigate interactions. Analyzed were root growth, growth of plant parts floated on solution and growth of grass leaf blades and leaf discs. During the last two years of the project, assays involved the use of isolated membrane vesicles (Sandelius et al. 1986).

Herbicides, retardants and surfactants

Amounts of all herbicides and retardants are reported as active ingredients. Examples include Embark^R = 1b/A as mefluidide (N-[2-4-dimethyl-5-[(trifluoromethyl)sulfonyl]amine]phenyl]acetamide); Telar^R or Glean^R = oz/A of chlorsulfuron (2-chloro-N-[4-methoxy-6-methyl-1,3,5-triazin-2-yl]aminocarbonyl]benzenesulfonamide); Manage^R = Glyphosate = sodium sesqui salt of [N-(phosphonomethyl) glycine]; Garlon^R = trichlopyr = 3,5,6-trichloro-2-pyridinyloxyacetic acid; 2,4-D amine = 1b/A of acid equivalent of the dimethylamine salt of 2,4-dichlorophenoxyacetic acid. Surfactants are given as % of the total spray mixture. Surfactant X-77^R was from Ortho. Surfactant WK^R was from DuPont. Other surfactants were from the manufacturers indicated.

Environmental studies

Evaluation of continuous Embark plots were initiated in 1977 and have been in effect for 10 years. Continuous Telar and Telar + Embark plots were initiated in 1983 and continuous Manage and Telar + Manage plots were initiated in 1987. Effects on root growth were determined by periodic removal of plants and evaluation and measurement of the entire root system in comparison to top growth. Environmental safety of recommended materials to fish, fresh water organisms, wildlife and non-target vegetation also was determined as was animal toxicity and potential to cause cancer and/or mutations in man.

Results

This research project was to reduce costs and increase efficacy of vegetation management along Indiana roadsides through a program of chemical mowing. The findings will show how low-cost additives can be used together with an effective primary growth retardant material to reduce application rates, eliminate unfavorable herbicide-retardant interactions and make chemical mowing cost-competitive and even less expensive than standard mechanical mowing.

Selection of the Primary Retardant

The primary retardant utilized in these studies, Embark (Mefluidide), was selected from a group of approximately 12 materials including Sustar, MH and Eptam that were available as potential growth retardants when the present investigation was initiated. Although the material was expensive and tended to cause some discoloration of turf, its strong features were effectiveness as a seedhead suppressant with fescue, overall environmental safety and lack of carry over from one season to the next. In subsequent investigations, Embark was adopted as the standard to which other primary retardants were compared as they became available for evaluation. These comparisons were extended to Manage, ACP 1900, EL 107, Mon 4625 and Mon 4529, to list a few, during the last two years of the project. While these evaluations are still incomplete, none of the other primary retardants tested has exhibited a clear superiority over Embark.

The initial difficulty with Embark was the high rates required to control seedheads in fescue (Fig. 1). With Embark alone, on the order of 3/4 lb/A was required. At a cost of more than \$30/lb, this amount would have been prohibitive. Toxicity to native bluegrass was also noted at these high rates of application.

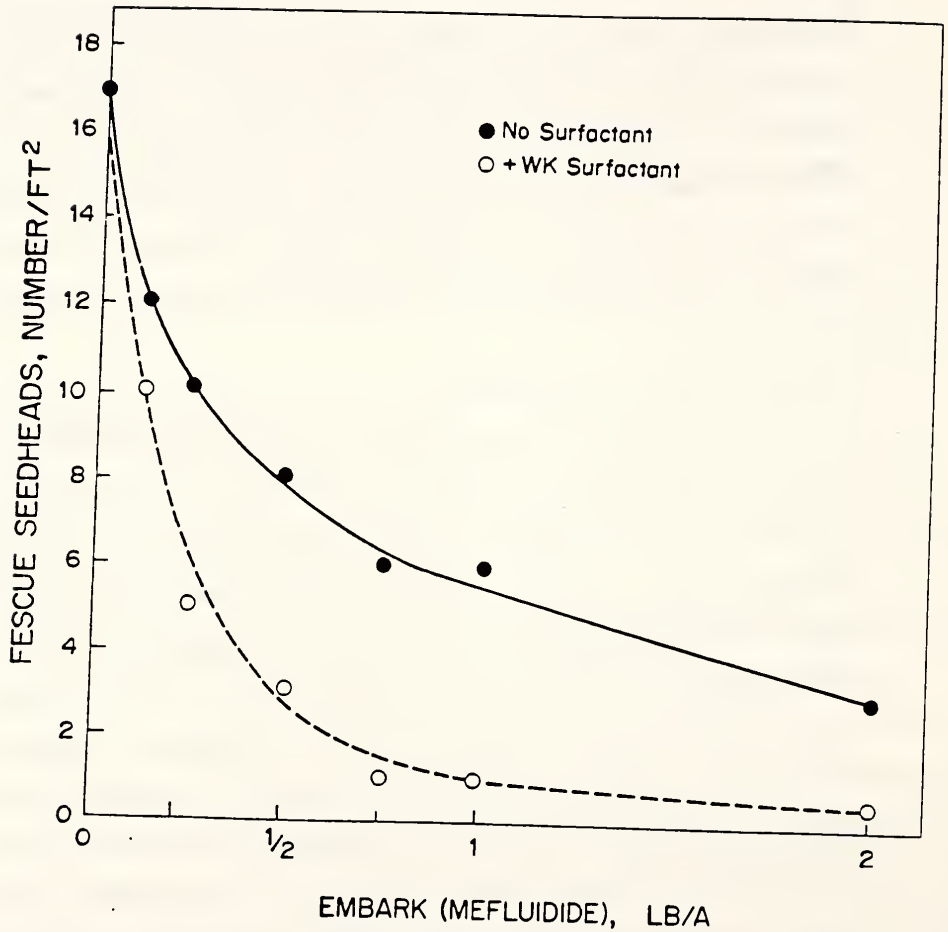


Fig. 1. Influence of application amount of Embark on seedhead formation in fescue. Applications were on May 3, 1983 under roadside conditions. WK surfactant was present as 0.5% of the total spray mixture. Fescue height was 11 + 1 inches at the time of spraying. Evaluations were on June 22, 1983. This experiment was repeated in the spring of 1984 and in the springs of 1985, 1986 and 1987 with X-77 surfactant with a similar outcome.

A second difficulty with Embark was an antagonism with 2,4-D herbicides (Table 1). Embark does not kill broadleaf weeds. Therefore, the retardant must be mixed with a weed control herbicide. 2,4-D, because of its low cost (\$1.70/lb) and broad-spectrum effectiveness would be the material of choice.

To overcome antagonism with 2,4-D (Table 1) and to reduce the required application rates (Fig. 1), a surfactant was added to the mixture. This low-cost (\$10.00/gallon) additive provided the first major breakthrough in the development of a cost-effective program of chemical mowing for Indiana roadsides.

Effect of surfactant

Surfactants greatly enhanced the effectiveness of Embark. The overall effect with seedhead suppression in fescue was to double the effectiveness of the primary retardant material, so that 90% control of fescue seedheads could be achieved at rates of Embark starting at 1/2 lb/A. This is illustrated in Table 1 where the three-combination of Embark + Surfactant + 2,4-D amine resulted in 89% suppression of seedheads in fescue under roadside conditions.

Initially, the manufacturers recommended rates of 0.5 or 1% surfactant (as percent of total in the spray mixture) were followed. Careful field studies conducted in 1982 demonstrated that 0.25% surfactant was just as effective as 0.5% surfactant at 40 gpa of total spray mixture (Fig. 2). This resulted in a cost saving of approximately \$1.00/acre in material costs compared to the 1% surfactant rate utilized initially.

While some surfactants tended to be more effective than others, these differences in the field tended to be minimized with time from date of treatment so that in the end the choice of surfactant was not critical. Among the three most effective surfactant materials tested were, WK (Fig. 1), XM-12 (Fig. 2) and X-77 (Table 2). X-77 was ultimately selected on the basis of ready commercial availability and environmental safety.

Table 1. Fescue seedhead suppression from Embark and antagonism between Embark and 2,4-D amine. Surfactant increases the effectiveness of Embark alone (see also Fig. 1) and largely eliminates the antagonism with 2,4-D.

Treatment (Rate per acre)	Seedheads per ft ²	Suppression %
None (Check)	18	0
Embark (1/2 lb/A)	9	50
Embark (1/2 lb/A) + 2,4-D amine (2 lb/A)	13	28
Embark (1/2 lb/A) + X-77 Surfactant (1%)	4	75
Embark (1/2 lb/A) + X-77 Surfactant (1%) + 2,4-D amine (2 lb/A)	2	89

Table 2. Comparison of WK, XM-12 and X-77 surfactants on seedhead formation and vegetative growth of tall fescue and bluegrass. Miami County adjacent to US 31. Applied April 12, 1983 using flood tip nozzles (F3) at 20 gpa. Evaluations were on June 16, 1983.

Treatment*	Fescue			Bluegrass		
	Seedhead No./10 ft ²	Ht.	Blade Ht.	Seedheads No./10 ft ²	Ht.	Blade Ht.
None (Check)	22	36	23	7	25	20
Embark (1/2 lb/A)	12	30	21	6	18	16
Embark (1/2 lb/A) + WK (0.25%)	9	29	20	5	19	17
Embark (1/2 lb/A) + XM-12 (0.25%)	10	29	20	4	19	17
Embark (1/2 lb/A) + X-77 (0.25%)	7	28	19	5	18	17

* All treatments included 2 lb/A 2,4-D amine except for the check which was untreated.

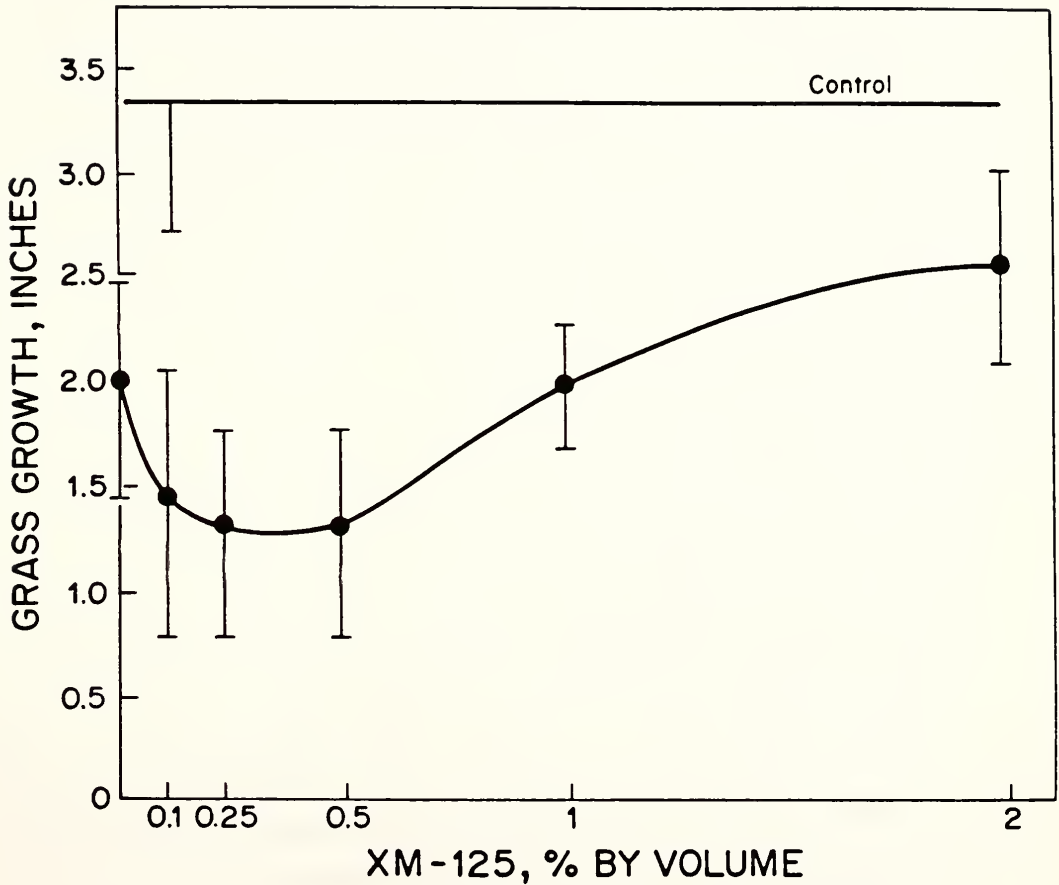


Fig. 2. Effect of rate of application of surfactant XM-12 on growth of mowed bluegrass in the field in the presence of 1/2 lb/A Embark plus 2 lb/A 2,4-D amine (acid equivalent). Each treatments was replicated 3 times. Growth measurements were 1 month after treatment. Values are the averages of four experiments (12 replicates total). The findings show that the concentration of surfactant as percentage of the total spray volume at 40 gpa can be reduced to as little as 0.25% without a reduction in treatment effectiveness. This small refinement resulted in a cost saving of \$1.00 per acre in material costs.

Effect of additives

A second way to increase effectiveness of the primary retardant was through synergistic interaction with other materials. While a synergistic interaction is possible with a number of different herbicides (examples include paclobutrazol, flurprimidol, bentazon, acifluorefen, sethoxydim, naptalam and various thiocarbamates such as Eptam), one of the most effective was with the du Pont products, Telar (chlorsulfuron) and Oust where just fractions of an ounce of the additive reduced the amount of primary retardant required by a factor of 2 or more (Table 3). An additional factor in the selection of Telar as the additive of choice to combine with Embark, surfactant and 2,4-D was the ability of Telar to control some 2,4-D resistant weed species such as wild carrot (Table 4).

Setting the rate of Telar

Rates of Telar of 1/2 oz per acre or greater were not considered due to phytotoxicity. There was a tendency for Telar alone to give 25 to 50% suppression of seedheads with rates in the range of 1/8 to 1 oz/A but with no obvious strict dose dependency (Fig. 3). Maximum effectiveness of Telar in the combination was obtained with 1/4 oz/A. In all five years of the study, 1/4 oz/A of Telar plus 1/4 lb/A of Embark were equivalent to 1/2 lb/A of Embark alone (Table 5). At \$12/oz for Telar, a treatment costing \$16/A for Embark alone was reduced to \$8/A for Embark plus \$3 per acre for Telar, an overall cost reduction of \$5/A in material costs.

However, further refinements in the rate of Telar may lead to even greater cost reductions. A detailed rate and date study completed in 1986 (Table 6) indicated that nearly equivalent results were obtained with a combination of 1/8 lb Embark + 1/8 lb Telar as compared to 1/4 lb Embark + 1/4 lb Telar to provide an additional cost reduction of \$5.50 per acre in costs of materials. Is even a further cost reduction possible through variations in the Embark + Telar combination? To check this possibility,

Table 3. Comparison of different rates of Embark alone and in combination with the additive Telar on seedhead suppression in fescue comparing 14 different dates of application between April 7 and May 16, 1984 under roadside conditions.

Schedule	Treatment and amount*				Control of fescue seedheads, %
	Embark	X-77	Telar	2,4-D Amine	
A	1/2 lb/A	0.25%	-	2 lb/A	79 \pm 15
B	1/4 lb/A	0.25%	1/4 oz/A	2 lb/A	88 \pm 11
C	1/8 lb/A	0.25%	1/8 oz/A	2 lb/A	90 \pm 11

Table 4. Control of wild carrot by Telar at varying rates under roadside conditions. Applications were on May 19, 1983 with evaluations on June 28.

Telar (oz/A)	Wild Carrot (plants/50 ft ²)
-	37
1/16	24
1/8	2
3/16	4
1/4	8
1/2	2
3/4	4
1	1

*Rates are lb/A of mefluidide for Embark, oz/A of chlorsulfuron for Telar and lb/A acid equivalent for 2,4-D amine. X-77 surfactant was as % of the total spray mixture applied at 40 gpa and 40 psi.

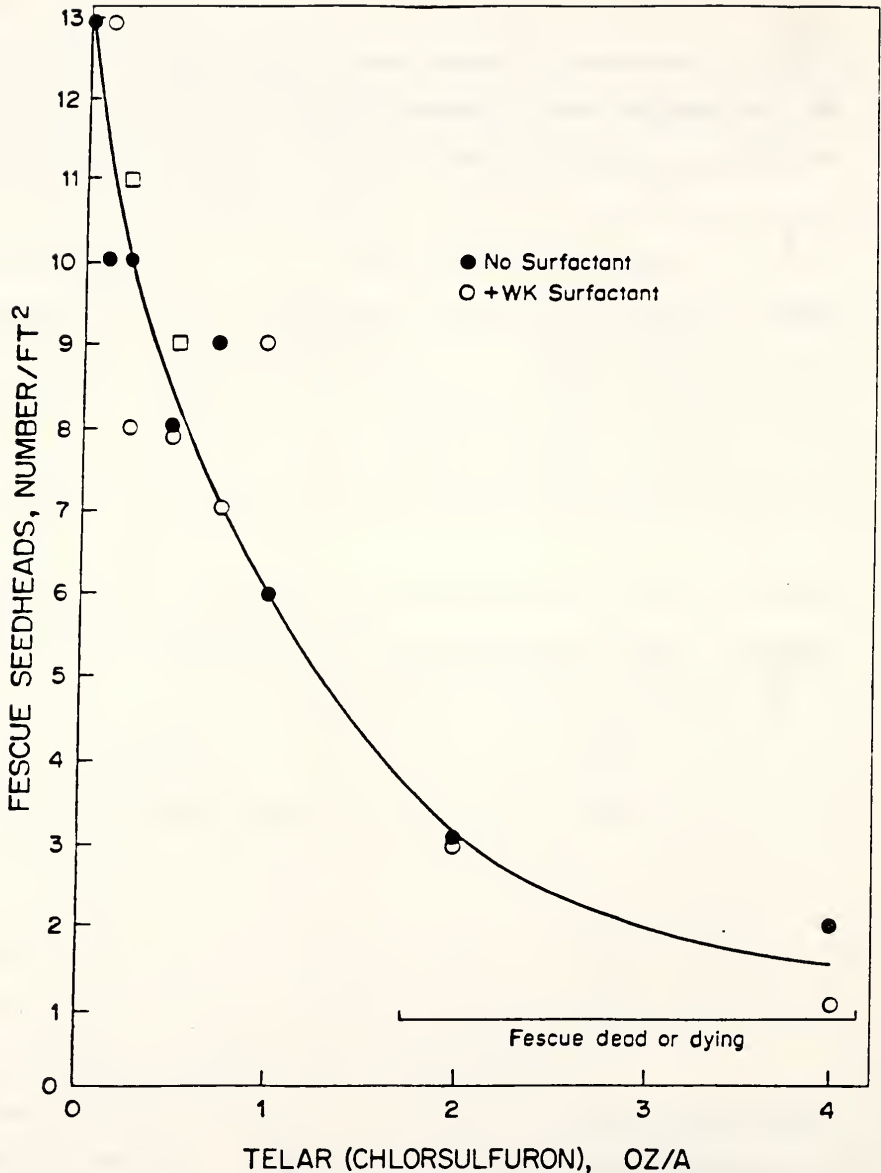


Fig. 3. Influence of application amount of Telar as chlorsulfuron on seedhead formation in fescue. Applications were on May 4, 1983 under roadside conditions. Evaluations were on June 23, 1983. WK surfactant, when present was 0.5% by volume of the total spray mixture (40 gpa; 40 psi). Fescue height at the time of spraying was 11 inches. The experiment was repeated in the spring of 1984 and again in the springs of 1985, 1986 and 1987 (the latter with 0.25% X-77 surfactant instead of WK) and with similar results.

Table 5. Embark in combination with surfactant and 2,4-D as influenced by the addition of Telar at early and late dates of application. 1983 test results under roadside conditions.

Date of Application	Amount/A				Fescue seedheads		Weeds per 100 ft ² <u>b/</u>	Cost per acre <u>c/</u>
	Embark	Surfactant ^{a/}	Telar	2,4-D	Per ft ²	Height (inches)		
March 18	-	-	-	-	12	47	160	
	1/2 lb	0.25%		2 lb	3	31	25	\$22.00
	1/4 lb	0.25%	1/4 oz	2 lb	2	29	25	\$17.00
May 3	-	-	-	-	17	46	124	
	1/2 lb	0.25%	-	2 lb	5	5	10	
	1/4 lb	0.25%	1/4 oz	2 lb	1	22	10	
May 9	-	-	-	-	17	46	64	
	1/2 lb	0.25%	-	2 lb	7	24	2	
	1/4 lb	0.25%	1/4 oz	2 lb	0	14	0	

a/ X-77 as percent by volume of the total spray mixture applied at 40 gpa and 40 psi

b/ Exclusive of common milkweed

c/ Based on Telar \$12/oz; Embark \$32/lb; 2,4-D \$1.60/lb; Surfactant \$10/gal.

Table 6 . Embark + Telar combinations, 1986 rate and date study. All treatment were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1986		Embark (lb) + Telar (oz) Rate/acre	Initial Height*	Fescue	
Applica- tion Date	Evaluation Date			Seedheads Per ft ²	Height*
March 12	May 25	Control	5	13 + 4	33 + 6
		1/4 lb + 1/4 oz		7 + 4	28 + 4
		1/8 lb + 1/8 oz		5 + 1	25 + 3
March 17	May 25	Control	5	11 + 2	30 + 1
		1/4 lb + 1/4 oz		6 + 4	25 + 3
		1/8 lb + 1/8 oz		7 + 2	21 + 3
March 25	May 25	Control	5	11 + 1	27 + 2
		1/4 lb + 1/4 oz		1 + 0	21 + 1
		1/8 lb + 1/8 oz		5 + 1	21 + 2
April 1	May 25	Control	6	12 + 0	25 + 1
		1/4 lb + 1/4 oz		2 + 2	20 + 1
		1/8 lb + 1/8 oz		2 + 1	18 + 1
April 8	May 25	Control	9.5	12 + 0	27 + 3
		1/4 lb + 1/4 oz		0 + 0	-
		1/8 lb + 1/8 oz		1 + 1	15 + 1
April 10	June 1	Control	10.5	12 + 1	48 + 8
		1/4 lb + 1/4 oz		0 + 0	-
April 12	June 1	Control	11	10 + 2	42 + 6
		1/4 lb + 1/4 oz		0 + 0	-
April 14A	May 21	Control	11.5	4 + 1	17 + 1
		1/4 lb + 1/4 oz		0 + 0	-
		1/8 lb + 1/8 oz		0 + 0	-
April 14B	May 25	Control	11	14 + 2	31 + 2
		1/4 lb + 1/4 oz		0 + 0	-
		1/4 lb + 1/8 oz		0 + 0	-
April 16	June 1	Control	12	12 + 1	41 + 1
		1/4 lb + 1/4 oz		0 + 1	11 + 2
April 17	May 22	Control	12	9 + 2	24 + 1
		1/4 lb + 1/4 oz		2 + 2	11 + 3
April 19	June 1	Control	12.5	11 + 1	42 + 5
		1/4 lb + 1/4 oz		0 + 0	-
April 21	May 25	Control	11	10 + 2	25 + 2
		1/4 lb + 1/4 oz		0 + 0	-
		1/8 lb + 1/8 oz		0 + 0	-

* Height in inches

Table 6 Continued. Embark + Telar combinations, 1986 rate and date study. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1986 Applica- tion Date	Evalua- tion Date	Embark (lb) + Telar (oz) Rate/acre	Fescue Initial Height*	Seedheads	
				Per ft ²	Height*
April 22	June 4	Control	12	9 + 2	33 + 5
		1/4 lb + 1/4 oz		0 + 1	(21)
		1/4 lb + 1/8 oz		1 + 1	(22)
April 23	June 1	Control	12.5	10 + 3	39 + 3
		1/4 lb + 1/4 oz		0 + 0	-
April 25	May 30	Control	12.5	9 + 3	36 + 0
		1/4 lb + 1/4 oz		1 + 1	24 + 4
April 28	June 4	Control	13	12 + 0	37 + 1
		1/4 lb + 1/4 oz		3 + 3	28 + 3
		1/8 lb + 1/8 oz		2 + 0	14 + 6
April 30	June 4	Control	13	9 + 1	35 + 2
		1/4 lb + 1/4 oz		6 + 4	34 + 3
		1/4 lb + 1/8 oz		4 + 3	33 + 3
May 2	June 4	Control	15	11 + 1	36 + 1
		1/4 lb + 1/4 oz		0 + 1	(12)
		1/4 lb + 1/8 oz		1 + 2	(25)
May 5	June 10	Control	15	12 + 2	40 + 4
		1/4 lb + 1/4 oz		1 + 1	20 + 2
May 6	June 10	Control	15	12 + 2	41 + 3
		1/4 lb + 1/4 oz		0 + 0	-
May 7	June 10	Control	16	12 + 2	36 + 1
		1/4 lb + 1/4 oz		2 + 1	18 + 4
May 14	June 4	Control	17	12 + 0	38 + 1
		1/4 lb + 1/4 oz		1 + 1	(20)
		1/8 lb + 1/8 oz		2 + 1	17 + 4
May 21	June 4	Control	22	6 + 2	29 + 3
		1/4 lb + 1/4 oz		6 + 0	25 + 2
		1/8 lb + 1/8 oz		3 + 1	25 + 2

* Height in inches

two additional series of experiments were carried out. In the one (Table 7), Embark was held constant at 1/4 lb/A and Telar was varied from 1/4 oz to 1/32 oz. In the other (Table 8), the ratio of Embark and Telar was held constant. Except with the latest application in early May, the amount of Telar combined with 1/4 lb Embark could not be reduced below 1/8 oz/A without loss of treatment effectiveness (Table 7). Similarly, treatments consisting of 1/4 lb Embark + 1/4 oz Telar, 3/16 lb Embark + 3/16 oz Telar, or 1/8 lb Embark + 1/8 oz Telar were all equivalent at all dates of application but dropping below 1/8 lb Embark + 1/8 oz Telar to 3/32 lb Embark + 3/32 oz Telar resulted in loss of effectiveness (Table 8). In both implementation tests in the Crawfordsville District and in small plots comparable to the 1986 studies, the combination of 1/8 lb Embark + 1/8 oz Telar failed to adequately control fescue seedheads (Tables 9 and 10) in the 1987 season. Thus, additional test results are needed to determine at what level cost reduction below 1/4 lb Embark + 1/4 oz Telar can be implemented. Possibilities requiring further study include 3/16 lb Embark + 3/16 oz Telar and 1/4 lb Embark + 3/16 or 1/8 oz Telar, as examples.

Addition of 2,4-D to the basic Embark + Telar combination

While giving excellent control of wild carrot and some other species, Telar is ineffective in the control of plantain, for example, a dominant turf weed species. Therefore, it was considered desirable to include a broadleaf herbicide such as 2,4-D amine in the chemical mowing mixture. Antagonism between Embark (alone or in combination with Telar) has been noted (Tables 1 and 11). However, combination of 2,4-D amine with surfactant increased weed control and lessened the 2,4-D/Embark antagonism (Tables 1 and 11). Maximum weed control was achieved in the range of 1.5 to 2 lb/A acid equivalent (Table 11, Part B). The antagonism between Embark and 2,4-D also was less at the higher 2,4-D rates (Table 11). Similar results were obtained in 1982, 1983 and 1984 regarding this latter point such that the rate of 2,4-D amine in the mixture was set at 2 lb/A.

Table 7 . Embark + Telar combinations, 1986 rate and date study in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture). Embark constant.

Application date:	April 14	April 22	April 30	May 2
Evaluation date:	May 25	June 4	June 4	June 4
FESCUE SEEDHEADS/ft ²				
Control	14 ± 2	9 ± 2	9 ± 1	11 ± 1
E 1/4 lb + T 1/4 oz	0 ± 0	0 ± 1	6 ± 4	0 ± 1
E 1/4 lb + T 3/16 oz	0 ± 1	1 ± 1	5 ± 1	2 ± 1
E 1/4 lb + T 1/8 oz	0 ± 0	1 ± 1	4 ± 3	1 ± 2
E 1/4 lb + T 3/32 oz	2 ± 1	4 ± 2	10 ± 3	2 ± 1
E 1/4 lb + T 1/16 oz	-	3 ± 1	8 ± 4	1 ± 1
E 1/4 lb + T 1/32 oz	-	4 ± 3	10 ± 2	6 ± 4
E 1/4 lb	9 ± 3	3 ± 3	4 ± 0	2 ± 1

Table 8. Embark + Telar combinations, 1986 rate and date study, in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture). Embark variable.

Application date:	April 14	April 21	April 28	May 7	May 14	May 21
Evaluation date:	May 21	May 25	June 4	June 4	June 4	June 4
FESCUE SEEDHEADS/ft ²						
Control	4 ± 1	10 ± 2	12 ± 0	11 ± 1	12 ± 0	6 ± 2
E 1/4 lb + T 1/4 oz	0 ± 0	0 ± 0	3 ± 3	0 ± 0	1 ± 1	6 ± 0
E 3/16 lb + T 3/16 lb	0 ± 0	0 ± 0	2 ± 1	0 ± 0	0 ± 0	4 ± 2
E 1/8 lb + T 1/8 lb	0 ± 0	0 ± 0	2 ± 0	0 ± 1	2 ± 1	3 ± 1
E 3/32 lb + T 3/32 lb	1 ± 1	4 ± 2	3 ± 1	1 ± 1	2 ± 2	5 ± 2
E 1/16 lb + T 1/16 lb	1 ± 0	3 ± 1	5 ± 1	4 ± 3	5 ± 2	10 ± 2

Table 9. 1987 evaluation of Embark/Telar application schedules B and C. Treatments were applied on April 16, 1987 with evaluation on May 29, 1987. IN-126 test area; 3 ft X 6 ft test plots. Initial height of the fescue was 12 inches.

Schedule	Amount per acre*				Fescue Seedheads	
	Embark	X-77	Telar	2,4-D Amine	Per ft ²	Height (inches)
-	-	-	-	-	11	39
B	1/4 lb	0.25%	1/4 oz	2 lb	1	23
C	1/8 lb	0.25%	1/8 oz	2 lb	3	25

* Rates are in pounds or ounces of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

Table 10. 1987 evaluation of Embark/Telar application schedule C. Treatments were applied about May 1, 1987 using Swinglok equipment on I-74 east of Crawfordsville Interchange under supervision of Don Bickle.

Schedule	Amount per acre*				Fescue Seedheads	
	Embark	X-77	Telar	2,4-D Amine	Per ft ²	Height (inches)
Control	-	-	-	-	13	39
C	1/8 lb	0.25%	1/8 oz	2 lb	6	26

* Rates are in pounds or ounces of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

Table 11. Comparisons of different rates of 2,4-D amine on mefluidide-2,4-D antagonism under roadside conditions. Applications were on May 6 (B) and 9 (A), 1982 with evaluations on May 26 (B) and June 7 (A). Values are \pm standard deviations.

	Treatment and amount			Seedheads per ft ²		Seedhead height (inches)	
	Mefluidide	XM-12*	2,4-D Amine	Fescue	Bluegrass	Fescue	Bluegrass
A	-	-	-	16.7 \pm 6.0	3.4 \pm 1.0	37.3 \pm 4.5	20.7 \pm 2.5
	1/2 lb/A	-	-	5.6 \pm 0.6	3.6 \pm 1.9	24.4 \pm 3.3	17.4 \pm 2.5
	1/2 lb/A	0.5%	-	4.6 \pm 0.8	1.3 \pm 1.3	18.3 \pm 1.5	13.5 \pm 0.7
	1/2 lb/A	-	2 lb/A	9.0 \pm 4.8	3.3 \pm 1.5	25.4 \pm 5.8	16.9 \pm 1.4
	1/2 lb/A	0.5%	2 lb/A	5.3 \pm 1.1	2.3 \pm 1.0	20.5 \pm 5.1	14.3 \pm 1.5
B	-	-	-	15.4 \pm 2.4	1.4 \pm 0.7	33.3 \pm 2.7	15.4 \pm 2.7
	1/2 lb/A	0.5%	1/2 lb/A	8.9 \pm 0.5	1.7 \pm 2.9	13.8 \pm 3.2	9.7 \pm 0.3
	1/2 lb/A	0.5%	1 lb/A	6.2 \pm 4.7	0.7 \pm 0.3	11.9 \pm 1.9	9.0
	1/2 lb/A	0.5%	2 lb/A	6.7 \pm 2.4	1.1 \pm 1.00	13.4 \pm 2.2	12.0 \pm 1.0

* XM-12 surfactant as percent of the total spray mixture.

A rate of 1 lb/A of 2,4-D amine was insufficient to enhance weed control significantly considering the wide range of species encountered in a roadside situation. Ester formulations of 2,4-D were not considered due to problems with volatility and toxicity to fish when directly oversprayed to streams. Only the environmentally safe, amine formulations of 2,4-D have been recommended for general roadside uses.

Alternatives to Telar as the additive

Oust, a chemical relative of Telar, has been under test as an alternative to Telar since 1983. In contrast to Telar, Oust showed a strong surfactant response (Fig. 4) and in the presence of surfactant was approximately twice as effective overall as Telar (Compare Fig. 4 with Fig. 3). Similarly, in combination with Embark, Oust is also more effective than Telar (Table 12), about twice. Its phytotoxicity is also about twice that of Telar but pound for pound it is less expensive than Telar. The main advantage of Telar over Oust in the mixture may be environmental safety.

A second alternative to Telar that has received extensive testing was a Dow product, Verdict. While effective, relatively high rates of Verdict were required to achieve seedhead suppression in fescue equivalent to that with 1/4 oz per acre of Telar in the mixture with Embark (Table 13).

Environmental Safety

Turf remained healthy and vigorous in a series of test plots receiving Embark applications (1/2 lb/A annually for 10 years since the spring of 1977. Neither Embark alone or Telar alone resulted in any permanent inhibition of root growth with fescue or bluegrass. Repeat applications of high rates of Embark (e.g. 1 or 2 lb/A) reduce or eliminate some strains of native bluegrass but fescue continues to grow vigorously even in those plots. Similarly, permanent deterioration of either bluegrass or fescue turf has not been noted in plots receiving Telar or Oust continuously since the spring of 1977.

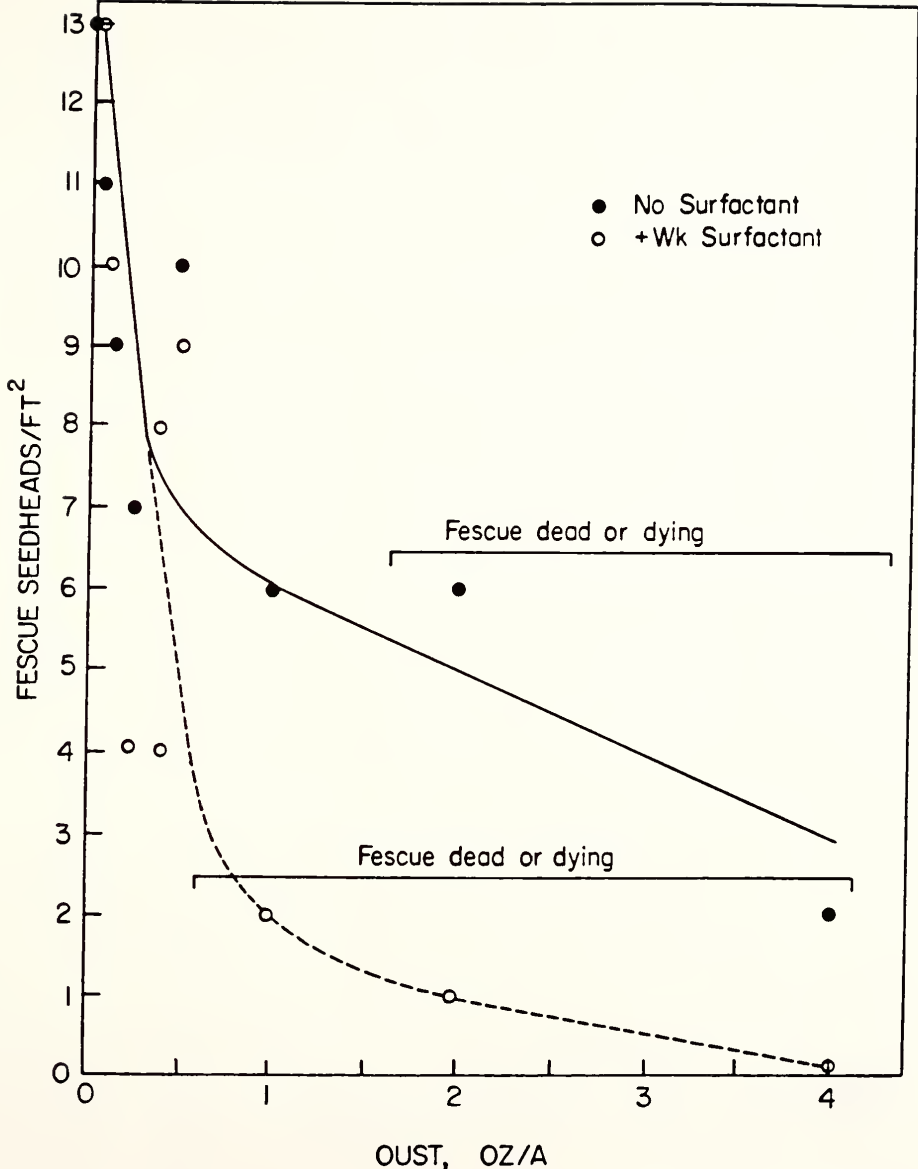


Fig. 4. Influence of application amount of Oust on seedhead formation in fescue. Applications were on May 4, 1983 under roadside conditions. Evaluations were on June 23, 1983. WK surfactant, when present, was 0.5% by volume of the total spray mixture (40 gpa; 40 psi). Fescue height at the time of spraying was 11 inches. The experiment was repeated in the spring of 1984 and again in the springs of 1985, 1986 and 1987 (the latter with 0.25% X-77 surfactant instead of WK) and with similar results.

Table 12. Comparison of varying rates of Oust and Telar for control of fescue seedheads in combination with Embark, IN-126 test area. Applied May 12 and 13, 1982. Evaluations were on June 27, 1983.

Embark	X-77	Amount per acre*			Fescue Per ft ²	Seedheads Height (inches)
		Telar	Oust	2,4-D Amine		
-	-	-	-	-	11 ± 1	35 ± 1
1/8 lb	0.5%	1/8 oz	-	2 lb	5 ± 4	27 ± 1
1/8 lb	0.5%	1/4 oz	-	2 lb	3 ± 2	24 ± 1
1/8 lb	0.5%	1/2 oz	-	2 lb	4 ± 5	21 ± 3
1/8 lb	0.5%	-	1/16 oz	2 lb	6 ± 3	29 ± 2
1/8 lb	0.5%	-	1/8 oz	2 lb	5 ± 1	29 ± 4
1/8 lb	0.5%	-	1/4 oz	2 lb	5 ± 1	29 ± 4
1/4 lb	0.5%	1/8 oz	-	2 lb	2 ± 4	25 ± 3
1/4 lb	0.5%	1/4 oz	-	2 lb	2 ± 0	24 ± 2
1/4 lb	0.5%	1/2 oz	-	2 lb	2 ± 3	25 ± 3
1/4 lb	0.5%	-	1/16 oz	2 lb	8 ± 2	32 ± 2
1/4 lb	0.5%	-	1/8 oz	2 lb	3 ± 4	29 ± 4
1/4 lb	0.5%	-	1/4 oz	2 lb	1 ± 2	22 ± 2

Table 13. Comparison of varying rates of Telar and Verdict in combination with Embark for seedhead control in fescue. Treatments applied on April 23, 1987 with evaluations on June 15, 1987. IN-126 test area.

Embark	X-77	Amount per acre*			Fescue Per ft ²	Seedheads Height (inches)
		Telar	Verdict	2,4-D Amine		
-	-	-	-	-	13	45
1/4 lb	0.25%	1/4 oz	-	2 lb	2	25
1/4 lb	0.25%	-	-	2 lb	6	39
1/4 lb	0.25%	-	1/16 lb	2 lb	6	38
1/4 lb	0.25%	-	1/8 lb	2 lb	4	35

* Embark = lb/A as mefluidide; X-77 = % by volume in total spray mixture; Telar, Oust and Verdict = oz/A of active material; 2,4-D = lb/A of acid equivalent of the dimethylamine salt.

In 1986, toxicity was noted in several areas that had been resprayed for the fourth successive year with a mixture of 1/4 lb/A of Embark plus 1/4 oz Telar plus surfactant and 2,4-D amine. Toxicity was also obtained with this treatment applied for the first time in 1986 in several areas and the basis for the observations remains unresolved. Areas treated for the fourth successive year with the mixture of 1/4 lb/A of Embark plus 1/4 oz Telar plus surfactant and 2,4-D amine in 1987 showed no evidence of similar toxicity. This type of long-range environmental testing, however, must be continued in order to spot potentially costly problems before they arise during the course of normal use practices.

Any of the treatments may display some initial discoloration (yellowing) of grass foliage in the second or third week post treatment. This discoloration is temporary and is usually gone when the vegetative growth of the grass resumes in 3 to 4 weeks after application.

No problems have been encountered from injury to nontarget species either due to drift or to inadvertent direct overspraying under normal roadside use conditions. All of the materials included in mixtures recommended for implementation have been determined to be safe to man, domestic animals, fish, aquatic food-chain organisms, and nontarget vegetation both by the manufacturer and in independent tests conducted as part of the environmental safety evaluations (mutagenicity and carcinogenicity assays, animal studies, toxicity to fish and algae, etc.) included among the project's objectives. The margin of safety for the Embark + Telar + 2,4-D + Surfactant combination is sufficiently high that an overdose of 2- to 4-times the recommended rates would not present an environmental hazard nor result in permanent turf damage.

Implementation tests, 1983-1987

In 1983, 1/2 lb/A Embark + 0.5% surfactant + 2 lb/A 2,4-D amine were tested successfully using commercial applicators and application equipment with seedhead suppression in fescue averaging about 80%. In 1984 through 1987, a spring application of 1/4 lb/A Embark + 1/4 oz Telar + 2 lb/A 2,4-D amine and 0.25% surfactant was tested and gave 90% control of seedheads of both fescue and bluegrass and of broad-leaf weeds (Table 14). These tests were on I-70 and the Illinois State Line. For most of the growing season, the area would not have required mowing. Its appearance was equivalent to adjacent road segments that had received 2 cycles of mechanical mowing. Only in the fall when native prairie species such as purple top formed seedheads was a clear need for mowing indicated.

Similar trials on secondary roads in Miami County in 1983 and in the Crawfordsville subdistrict in 1984 through 1987 were less encouraging. The treatments were effective in controlling seedheads in fescue and bluegrass as on the Interstates and dual lane roads. However, the treatments were much less effective on smooth brome that is frequently present along secondary roads in scattered patches and becomes unsightly as seedheads are formed. Also growth of late germinating weeds (such as velvetleaf) and annual grasses (such as giant foxtail and barnyard grass) tended to dominate narrow rights-of-way adjacent to cropped fields late in the growing season.

Both the problem with the smooth brome and the late germinating annual weeds and grasses received extensive study during the final two years of the project. To overcome the late germinating annual weeds, an appropriate pre-emergence material was added to the spray mixture. For control of smooth brome, a new mixture containing Garlon-4 was developed. Both these mixtures are ready for early implementation testing in 1988.

Table 14. Evaluation of a spring application of 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + 0.25% X-77 (by volume of total spray mixture) (25 gpa/Swinglok), applied by the Indiana Department of Highways, under actual highway use conditions. Treatments were on April 18, 1984. Evaluations were on August 24, 1984, 4 months after application. I-70 between Indianapolis and the Indiana State line

	Fescue ^a				Bluegrass ^a			
	Seedheads		Blade height		Seedheads		Blade height	Weeds/ 1000 ft ²
	per ft ²	height			per ft ²	height		
Median:								
Unsprayed	17 ± 1	39 ± 2	15 ± 4		12 ± 4	21 ± 1	13 ± 2	391
Sprayed	2 ± 3	20 ± 5	14 ± 3		2 ± 1	13 ± 3	10 ± 2	30
Control	90%				83%			92%
Pavement to Ditch:								
Unsprayed	15 ± 3	37 ± 2	18 ± 3		7 ± 2	21 ± 1	14 ± 2	468
Sprayed	1.6±1.1	24 ± 2	14 ± 2		9.7±0.6	14 ± 2	11 ± 1	62
Control	90%				90%			87%

^a Based on measurements from 4 different locations selected at random. Heights are average maximum heights from 10-20 plants per location ± standard deviation among different locations. Rates are of active ingredient. Initial height of bluegrass was 3.5-4 inches. Initial height of fescue was 6-7 inches.

Herbicides for control of late germinating annual grasses and weeds along treated secondary roads

A number of herbicides were mixed with the standard materials of 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D (+ surfactant) for control of late germinating annual grasses and weeds which are frequent invaders from adjacent crop lands on secondary roads (Table 15A). Thus far the best material has been an Ilanco product, Balan, although Surflan and Treflan show similar promise for roadside use.

Typical test results are summarized in Table 15B. The criterion chosen for initial evaluation of treatment effectiveness has been control of foxtail. With Balan, control of foxtail in test plots has been about 90%. A major consideration in favor of Balan for roadside use is its very low toxicity to established turf. Environmental tests have been conducted where the material has been used at the 3 lb/A rate for 4 successive years without ill effects.

In 1986, the Balan treatment was implementation tested on a segment of 136N between Lizton and New Ross. The application consisted of 1/4 lb/A of Embark plus 2 lb/A 2,4-D amine to which was added 3 lb/A of Balan. Control of yellow foxtail, giant foxtail and barnyard grass in his test was about 80% and those plants present at the time of evaluation on July 25 were about half as tall as those in unsprayed check plots. The application was made quite late, however, on May 13 so that fescue seed heads had already started to form.

Implementation tests in 1987 included Surflan (2 and 3 quarts/acre) and Treflan (2 quarts/A) for control of foxtail. No injury to fescue or bluegrass turf was noted from these treatments and both materials emerge as excellent candidates as pre-emergence agents to combine with Embark and Telar in a mixture for use on secondary roads.

Table 15A. Summary of pre-emergence herbicide materials tested in combination with Embark, Telar, 2,4-D amine and X-77 surfactant for vegetation management along secondary roads with emphasis on control of giant foxtail and annual weeds.

Balan	1-3 lb/A	EL-107	1-2 lb/A
Betasan	10-20 lb/A	Treflan	1-2 lb/A
Surflan	1-2 lb/A	Starane	1/2-1 lb/A
Prowl	1.5 lb/A	Sanalan	2-16 lb/A
Poast	0.2 to 0.6 lb/A	Tridiphane	1/4-1 lb/A
Fusilade	0.25 to 0.4 lb/A	Chlopyralid	1/4-2 lb/A
Goal	0.25 to 0.5 lb/A	Trichlopyr	1/4-2 lb/A
Hoelon	0.75 to 1.5 lb/A		
Dinitrophenol	0.25 to 1 lb/A		
Premerge	0.25 to 1 lb/A		
Roundup	1 lb/A		

Table 15B. Control of giant foxtail comparing several pre-emergence herbicides combined with Embark, Telar, 2,4-D amine and X-77 surfactant applied May 14-May 18, 1984 with evaluations on August 21, 1987. White County, Indiana.

Treatment	Foxtail	
	per 10 ft ²	height (inches)
Control	15	30
Standard mix (1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + surfactant)	15	28
Standard mix + Balan 3 lb/A	2	23
Standard mix + Poast 0.3 lb/A	10	19
Standard mix + Betasan 20 lb/A	6	28

Secondary Road Test: 1986. List of Treatments. Area sprayed was 136 N from Lizton to New Ross. Applied May 13, 1986. Evaluation was on July 25, 1986. Treatments were applied without Telar and without surfactant. Telar (1/4 oz/A) + 2,4-D, (1b/ were applied 1-2 days later. Plots were 2 acres in area and about 1 mile long. Fescue seedheads were showing when the area was sprayed. Rate of application: 25 gp

Treatment Number	Amount per Acre											
	Embark	2,4-D	Poast	Crop Oil	Round Up	Balan	Embark	2,4-D	Poast	Crop Oil	Round Up	Balan
0	-	-	-	-	-	-	-	-	-	-	-	-
1	1 pt	1/2 gal	1 qt	-	-	-	1/4 lb	2 lb	1/2 lb	-	-	-
2	1 pt	1/2 gal	2 qt	1 qt	-	-	1/4 lb	2 lb	1 lb	1 qt	-	-
3		1/2 gal	1 qt	1 qt	-	-	1/4 lb	2 lb	1/2 lb	1 qt	-	-
4	-	-	-	-	6 oz	-	-	-	-	-	6 oz	-
5		1/2 gal	-	-	-	1 1/2 gal	1/4 lb	2 lb	-	-	-	3 lb

Secondary Road Test: 1986. Effect of Seedhead Formation in Roadside Turf Grasses

Treatment Number	Fescue			Bluegrass		Smooth Brome		Orchard Grass		Timothy	
	SH/Ft ²	SH Ht	Bld Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht
0 (Check)	15+3	39+2	27+3	6+2	30+3	14+2	50+3	14+3	44+4	12+4	41+1
1	10+5	24+6	18+1	14+2	18+2	7+2	29+4	10+9	31+9	-	-
2	0+0	-	21+1	3+1	16+2	10+4	26+6	4+3	16+1	1+0	29+1
3	0+0	-	19+1	3+1	14+0	2+2	24+6	2+4	15+3	-	-
4	12+4	29+6	25+2	7+1	31+6	11+3	34+6	8+4	23+2	-	-
5	18+2	24+1	25+1	5+5	16+1	6+2	34+2	3+2	34+2	-	-

Secondary Road Test: 1986. Treatment Notes

0 (Check)	Essentially no weeds except for plantain and a few carrot skips. Had been sprayed with Telar/2,4-D mixture.
1	Good evidence of smooth brome control. No injury obvious.
2	Good control. No injury.
3	Burning of fescue. Killed? Foxtail growth delayed.
4	No evidence of injury.
5	No yellowing at any time. About 80% control of foxtail and annual grasses. Sprayed too late and without Telar. Fescue seedheads showing when sprayed

Secondary Road Test: 1986. Control of Foxtail and Annual Grasses. Sampled adjacent to pavement where stands were heaviest.

Treatment Number	Yellow Foxtail		Giant Foxtail		Barnyard Grass*		Notes
	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	
0 (Check)	4 ± 3	27 ± 2	4 ± 1	22 ± 1	3 ± 2	24 ± 4	Foxtail just beginning to form seed heads.
1	8 ± 1	16 ± 4	7 ± 1	25 ± 6	3 ± 2	24 ± 4	No control in number.
2	6 ± 6	15 ± 3	1 ± 1	18 ± 1	2 ± 1	22 ± 8	Growth delayed.
3	8 ± 4	17 ± 10	4 ± 2	22 ± 7	2 ± 1	21 ± 9	Growth delayed.
4	8 ± 1	20 ± 2	4 ± 2	31 ± 6	4 ± 1	31 ± 7	No effect. Like check.
5	1 ± 1	10 ± 3	1 ± 1	11 ± 2	1 ± 1	12 ± 2	About 80% control.

*Results with Crabgrass were similar.

Growth-retardant mixtures for control of seedheads in smooth brome

A major limitation for use of the Embark-Telar-2,4-D Amine-Surfactant mixtures on secondary roads is its inability to control seedheads in smooth brome. This grass species occurs widely in small patches and clumps, forms tall, unsightly seed heads and is resistant to both Embark and the Embark-Telar combination. For use along secondary roads, a new mixture was sought that would control seedheads in smooth brome as well as in other roadside species.

The first possibility indicated was the use of the herbicide Poast (Stehoxydim by BASF). Added to the standard mixture at a rate of 0.3 lb/A, seedhead suppression was observed with smooth brome as well as orchard grass, both species resistant to the Embark-Telar-2,4-D Amine-Surfactant mixture (Table 16). In a toxicity trial initiated in the fall of 1984 (Table 17), there was no evidence of long term toxicity to fescue from the addition of Poast to the mixture.

A 1985 implementation test verified activity for the Poast combination although seedhead control in smooth brome was not complete (Table 18). These results were confirmed in the 1986 test summarized on page 29. Here Treatment 1 which was an Embark-Poast combination gave reasonable control of seedheads in smooth brome and orchard grass and the activity was enhanced considerable at the 0.5 lb/A rate of Poast by the addition of 1 quart per acre of crop oil. The increased efficacy of the Poast + crop oil treatment compared to Poast alone was confirmed in 1986 (Table 19) and again in 1987 where the standard mixture of 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + X-77 Surfactant in combination with 0.3 to 0.75 lb/A Poast + 1 qt/A crop oil gave 80 to 90% control of seedheads of smooth brome (Table 20) and of orchard grass. Considerable discoloration of fescue was observed, however, and a less toxic alternative was sought.

Table 16. Poast herbicide, in combination with Embark (1/4 lb/A), Telar (1/4 oz/A), 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% by volume of the total spray mixture) on seedhead formation in tall fescue, smooth brome and orchardgrass. Applied May 14, 1984. Evaluations were on August 21, 1984. White County, Indiana.

Treatment	Seedheads					
	Fescue		Smooth Brome		Orchard Grass	
	Per ft ²	Height (inches)	Per ft ²	Height (inches)	Per ft ²	Height (inches)
Control	19	40	13	37	13	37
Standard Mix	1	22	13	41	10	26
Standard Mix + 0.3 lb/A Poast	0	21	5	25	3	11

Table 17. Comparison of the pre-emergence herbicide Poast alone or in combination with the standard mixtures of Embark, Telar, Surfactant and 2,4-D as schedule B (1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + X-77 surfactant, 0.25% of the total spray mixture) or as Schedule C (1/8 lb/A Embark + 1/8 oz/A Telar + 2 lb/A 2,4-D amine + X-77 surfactant, 0.25% by volume of the total spray mixture) on growth and survival of fescue under roadside conditions. Applications were on August 29, 1984. Evaluations were on April 6, 1985. IN-126 test area.

Poast lb/A	In combination with schedule:	Fescue height (inches)	Fescue plants per ft ²
None	None	8 + 2	19 + 1
0.3	None	8 + 1	20 + 2
0.3	C	7 + 1	23 + 6
0.3	B	8 + 1	25 + 6
0.5	None	8 + 1	20 + 2
0.5	C	8 + 1	29 + 4
0.5	B	7 + 1	24 + 6
0.75	None	8 + 1	20 + 2
1.0	None	8 + 1	20 + 3
2.0	None	8 + 1	17 + 6
8.0	None	6 + 1	14 + 6

Table 18. Roadside implementation test of 0.35 lb/A Poast added to the standard mixture according to either schedule B or schedule C on seedhead formation in fescue, bluegrass, smooth brome and orchardgrass. Applied with Swinglok equipment. US 231 north of Crawfordsville. Applied on May 2, 1985. Evaluated on July 26, 1985.

Schedule ^a	Fescue		Seedheads (SH)/ft ² and seedhead and blade (Bld) heights (Ht)				Broadleaf	
	SH/ft ²	SH Ht	Bld Ht	SH/ft ²	SH Ht	Bld Ht	SH/ft ²	SH Ht
None	14±2	36±5	14±3	11±1	23±1	14±1	16±2	38±7
B + Poast ^c	0±0 (10)	10±0	2±1	6±1	5±1	6±2	27±1	1±0
C + Poast ^c	1±1	13±1	10±1	11±1	10±1	7±1	13±1	31±1
							3±1	14±1
								136 ^b
								0
								0

^a Schedule B = 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + 0.25% by volume of the total spray mixture of X-77 surfactant.

Schedule C = 1/8 lb/A Embark + 1/8 oz/A Telar + 2 lb/A 2,4-D amine + 0.25% by volume of the total spray mixture of X-77 surfactant.

^b Weed composition of control (plants/100 ft²): wild carrot 36, buckhorn plantain 62, sweet clover 12, red clover 6, other 8.

^c Rate per acre of Poast = 0.35 lb. Treated grass was very green. No evidence of toxicity.

Table 19. Varying rates of Poast with or without crop oil in combination with the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D amine on seedhead formation in smooth brome. Applied May 1, 1986. Evaluations were on May 28, 1986. IN-126 test area. 3' X 6' plots. Initial height of the smooth brome was 17 inches.

Embark	Amount per acre*					Smooth brome seedheads	
	X-77	Telar	2,4-D Amine	Poast	Crop Oil	Per ft ²	Height
-	-	-	-	-	-	11 ± 1	36 ± 0
1/4 lb	0.25%	1/4 oz	2 lb	-	-	10 ± 2	34 ± 2
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	-	10 ± 2	33 ± 2
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	-	7 ± 3	28 ± 8
1/4 lb	0.25%	1/4 oz	2 lb	1/8 lb	1/2 qt	10 ± 2	30 ± 6
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	1 qt	8 ± 2	27 ± 3
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	2 qt	4 ± 2	20 ± 2

* Embark = 1b/A as mefluidide, X-77 = % by volume of total spray mixture; Telar = oz/A of active material; 2,4-D and Poast = 1b/A of active material, crop oil = quarts/acre.

Table 20. Seedhead suppression in smooth brome using Poast with and without crop oil. Application was on May 13, 1987. Evaluation was on June 5, 1987. IN 126 test area. Smooth brome initial height 23 in.

Embark	Amount per acre					Smooth brome seedheads	
	X-77	Telar	2,4-D Amine	Poast	Crop Oil	Per ft ²	Height
-	-	-	-	-	-	14 ± 2	44 ± 4
1/4 lb	0.25%	1/4 oz	2 lb	0.3 lb	-	7 ± 1	35 ± 3
1/4 lb	0.25%	1/4 oz	2 lb	0.3 lb	1 qt	3 ± 1	24 ± 4

As a result of thistle control studies, Garlon (trichlopyr, Dow) was found to suppress formation of seedheads in smooth brome and orchardgrass when included in the growth retardant mixtures containing Embark, Telar, 2,4-D and surfactant. Garlon herbicides have activity against broadleaf weeds and have been investigated for control of Canada thistle, perennial milkweed and wild carrot along roadsides.

Initial testing concentrated heavily on combinations of Garlon with Embark and Verdict plus 2,4-D and in combination with Manage, a new primary retardant material. These results plus an Garlon-2,4-D-Embark antagonism are documented in Appendix II. The best treatment thus far is a combination of 1/2 lb/A of Garlon with the standard mixture of Embark, Telar and Surfactant but with a reduced amount of 2,4-D (Table 21). Because Garlon itself possesses herbicide activity against broad-leaf weeds as does Telar, it may not be necessary to include any 2,4-D amine in the combination. Some variation on this basic mixture of Embark, Telar, Surfactant and Garlon now appears as a likely solution to the problem with chemical mowing along secondary roads but will require several more seasons of testing and refinement before a definite recommendation can be made.

Manage as a primary grass retardant

Manage (Glyphosate, Monsanto) was introduced in 1986 as an industrial turf growth regulator in Indiana. Evaluation of the initial test sites suggested effectiveness in the control of seedheads in fescue and bluegrass at rates of about 6 oz/A in combination with 1/4 oz/A of Telar or 1/8 oz/A of Oust (Appendix I). Testing was continued in 1987 with confirmation of major findings.

On 21 different dates, Manage alone or in combination with Telar (Table 21) or with Oust (Table 22) was applied at different rates and ratios together with 2,4-D amine at 2 lb/A and 0.25% by volume of X-77 surfactant in the total

Table 21. Manage and Manage + Telar combinations, 1987 Rate and date study.

All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1987 Applica- tion Date	Evalua- tion Date	Manage + Telar (oz/acre)	Fescue			Bluegrass		
			Initial Height*	Seedheads Per ft ²	Height*	Initial Height*	Seedheads Per ft ²	Height
April 10	May 29	Control	11	14 + 2	42 + 4	7	4 + 1	36 + 1
		6 oz		10 + 4	38 + 2		2 + 1	31 + 2
		6 oz + 1/4 oz		11 + 2	41 + 2		1 + 1	33 + 4
April 13	May 13	Control	11	11 + 2	32 + 2	7	6 + 2	30 + 2
		2 oz		15 + 3	30 + 1		5 + 3	26 + 4
		2 oz + 1/4 oz		9 + 6	34 + 4		5 + 5	31 + 5
		4 oz		8 + 3	23 + 4		5 + 1	27 + 2
		4 oz + 1/4 oz		3 + 1	23 + 2		3 + 1	24 + 1
		6 oz		14 + 4	26 + 3		5 + 1	26 + 2
		6 oz + 1/4 oz		8 + 3	26 + 2		4 + 2	21 + 1
April 13	May 31	Control	11	14 + 2	44 + 2	8	6 + 0	27 + 1
		4 oz		9 + 4	35 + 10		0 + 0	-
		4 oz + 1/4 oz		12 + 0	29 + 3		0 + 1	(16)
		4 oz + 1/8 oz		12 + 2	34 + 2		1 + 1	17 + 2
April 20	May 17	Control	11	11 + 2	38 + 2	8	2 + 2	33 + 2
		6 oz + 1/4 oz		2 + 2	17 + 4		1 + 1	11 + 2
April 24A	June 22	Control	12	13 + 1	44 + 3	8	7 + 4	26 + 2
		4 oz		5 + 3	29 + 1		4 + 4	14 + 1
		4 oz + 1/4 oz		4 + 1	32 + 2		2 + 1	15 + 1
April 24B	June 1	Control	13	14 + 2	41 + 6	9	5 + 3	21 + 4
		3 oz + 1/4 oz		6 + 2	23 + 2		3 + 3	13 + 3
April 27	June 13	Control	14	13 + 1	47 + 1	12	4 + 2	32 + 4
		4 oz		5 + 3	33 + 5		1 + 2	18 + 2
April 28	June 14	Control	16	13 + 1	45 + 6	12	4 + 0	31 + 2
		3 oz + 1/4 oz		6 + 2	27 + 5		3 + 2	27 + 5
		4 oz		4 + 2	32 + 6		3 + 1	17 + 3
		4 oz + 1/16 oz		6 + 2	26 + 7		2 + 1	16 + 2
		4 oz + 1/8 oz		4 + 2	27 + 3		3 + 2	17 + 1
		4 oz + 1/4 oz		5 + 1	29 + 3		3 + 1	16 + 1
		4 oz + 3/8 oz		6 + 2	30 + 8		3 + 1	17 + 3
		6 oz		6 + 0	28 + 4		5 + 1	15 + 3
		6 oz + 1/8 oz		3 + 1	24 + 2		3 + 0	16 + 2
April 30	June 25	Control	16	2 + 1	21 + 2	12	1 + 1	12 + 2
		4 oz		15 + 1	46 + 3		7 + 2	26 + 5
		4 oz		6 + 1	29 + 0		4 + 4	17 + 2
		4 oz + 1/4 oz		3 + 1	28 + 2		6 + 6	13 + 3
May 1	June 3	Control	16	15 + 1	47 + 2	12	3 + 2	23 + 5
		4 oz + 1/4 oz		0 + 1	-		3 + 1	17 + 2
May 4A	June 16	Control	16	14 + 2	48 + 1	12	3 + 2	27 + 2
		4 oz		8 + 4	31 + 3		1 + 1	16 + 0

* Height in inches

Table 21 Continued. Manage and Manage + Telar combinations, 1987 Rate and date study. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1987 Applica- tion Date	Evalu- ation Date	Manage + Telar (oz/acre)	Fescue			Bluegrass		
			Initial Height*	Seedheads Per ft ²	Height*	Initial Height*	Seedheads Per ft ²	Height*
May 4B	June 4	Control	16	16 + 2	45 + 3	12	3 + 1	24 +
		4 oz + 1/4 oz		0 + 1	(22)		3 + 1	18 +
May 4C	June 28	Control	16	16 + 2	42 + 3	13	6 + 0	26 +
		2 oz		8 + 2	36 + 2		8 + 4	20 +
		2 oz + 1/4 oz		2 + 2	27 + 4		4 + 2	17 +
		4 oz		4 + 1	25 + 3		4 + 0	17 +
		4 oz + 1/4 oz		1 + 1	24 + 4		4 + 1	16 +
		6 oz		2 + 1	25 + 3		4 + 1	18 +
		6 oz + 1/4 oz (TOXIC)		1 + 1	23 + 3		4 + 0	17 +
May 6	June 28	Control	15	14 + 2	45 + 2	16	5 + 1	26 +
		4 oz		9 + 5	35 + 10		4 + 1	18 +
		4 oz + 1/32 oz		9 + 5	32 + 5		5 + 1	18 +
		4 oz + 1/16 oz		4 + 2	28 + 6		4 + 2	21 +
		4 oz + 3/32 oz		6 + 3	25 + 4		5 + 1	16 +
		4 oz + 1/8 oz		4 + 2	23 + 5		3 + 0	16 +
		4 oz + 5/32 oz		3 + 2	26 + 2		5 + 1	16 +
		4 oz + 3/16 oz		3 + 1	27 + 5		5 + 3	17 +
May 7	July 1	Control	18	16 + 4	44 + 3	19	5 + 1	26 +
		3 oz		9 + 6	32 + 2		7 + 2	20 +
		3 oz + 1/8 oz		4 + 3	28 + 8		6 + 2	16 +
		3 oz + 1/4 oz		8 + 6	34 + 12		5 + 1	18 +
May 8	May 20	Control	19	10 + 2	36 + 2		2 + 2	20 +
		2 oz + 1/4 oz **		3 + 1	28 + 1		1 + 1	22 +
		3 oz + 1/8 oz		4 + 1	22 + 2		1 + 1	19 +
		3 oz + 1/4 oz		4 + 2	23 + 2		1 + 1	18 +
		4 oz + 1/4 oz		8 + 2	27 + 3		2 + 1	22 +
		6 oz + 1/4 oz		3 + 1	22 + 2		3 + 2	23 +
May 9	July 1	Control	19	14 + 2	40 + 6	19	6 + 2	25 +
		3 oz + 1/8 oz		13 + 3	40 + 2		5 + 1	26 +
		3 oz + 1/4 oz		13 + 3	27 + 6		4 + 1	20 +
		4 oz + 1/8 oz		13 + 3	34 + 14		4 + 1	22 +
		4 oz + 1/4 oz		13 + 1	25 + 1		6 + 2	21 +
May 12A	July 15	Control	23	17 + 1	42 + 4			
		3 oz + 1/8 oz		9 + 3	30 + 1			
		6 oz + 1/4 oz		10 + 1	28 + 1			
May 12B	June 5	Control		11 + 1	35 + 1		3 + 1	21 +
		4 oz		3 + 1	23 + 1		2 + 1	15 +
May 13	June 2	Control	22	11 + 1	34 + 2	13	1 + 1	15 +
		6 oz	TOXIC	5 + 3	19 + 1		1 + 1	12 +

* Height in inches

** Contained 4 lb/A Balan

Table 21 Continued. Manage and Manage + Telar combinations, 1987 Rate and date study. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1987 Applica- tion Date	Evalua- tion Date	Manage + Telar (oz/acre)	Fescue			Bluegrass		
			Initial Height*	Seedheads Per ft ²	Height*	Initial Height*	Seedheads Per ft ²	Height
May 15	June 6	Control	26	12 + 0	38 + 0	27	2 + 0	21 + 3
		4 oz		11 + 1	25 + 1		4 + 0	18 + 2
		4 oz + 1/4 oz		11 + 1	23 + 3		1 + 0	18 + 2
Average all dates	(21)	Control	15	14 + 2	39 + 12	12	4 + 2	26 + 5
	(2)	2 oz		12 + 4	33 + 3		6 + 2	23 + 3
	(3)	2 oz + 1/4 oz		5 + 4	30 + 4		3 + 2	23 + 7
	(1)	3 oz		9 + 6	32 + 2		7 + 2	20 + 2
	(3)	3 oz + 1/8 oz		9 + 4	33 + 6		6 + 0	21 + 4
	(4)	3 oz + 1/4 oz		8 + 3	28 + 5		4 + 1	20 + 6
	(10)	4 oz		6 + 2	28 + 4		3 + 1	18 + 4
	(1)	4 oz + 1/32 oz		9 + 5	32 + 5		5 + 1	18 + 3
	(2)	4 oz + 1/16 oz		5 + 1	27 + 1		3 + 1	18 + 3
	(1)	4 oz + 3/32 oz		6 + 3	25 + 4		5 + 1	16 + 1
	(4)	4 oz + 1/8 oz		8 + 5	30 + 5		3 + 1	18 + 3
	(1)	4 oz + 5/32 oz		3 + 2	26 + 2		5 + 1	16 + 2
	(1)	4 oz + 3/16 oz		3 + 1	27 + 5		5 + 3	17 + 1
	(11)	4 oz + 1/4 oz		5 + 5	26 + 3		3 + 2	18 + 3
	(1)	4 oz + 3/8 oz		6 + 2	30 + 8		3 + 1	16 + 1
	(5)	6 oz		7 + 5	27 + 7		3 + 4	20 + 8
	(1)	6 oz + 1/8 oz		3 + 1	24 + 2		3 + 0	16 + 2
	(7)	6 oz + 1/4 oz		5 + 4	25 + 8		2 + 1	20 + 8
	(19)	Manage (all rates)		10 + 7	30 + 5		4 + 2	19 + 5
	(43)	Manage + Telar (all rates)		6 + 4	27 + 6		3 + 1	19 + 5
April 13, 18, 24, 28, and 30, May 4, 6 and 15	(8)	Control		14 + 2	42 + 5		5 + 2	27 + 3
	(8)	4 oz		7 + 3	29 + 5		3.5 + 1.5	18 + 4
	(8)	4 oz + 1/4 oz		5 + 4	27 + 3		3 + 2	15 + 6

* Height in inches

mixture. Manage at 3, 4 or 6 oz per acre gave essentially equivalent results with about 50% control of fescue seedheads and a 40% reduction in seedhead elongation. Rates of Manage at 6 oz/A or above could not be used practically in a roadside program due to toxicity to bluegrass. Rates of Manage of 2 oz/A or less were largely ineffective.

Addition of Telar to the combination with Manage increased effectiveness somewhat and was most effective at low rates of Manage. The effectiveness of Telar was maximal between 1/16 and 3/32 oz/A. Increasing the amount of Telar to 3/8 oz/A had no additional effect.

At a near optimum rate of Manage of 4 oz/A, fescue seedhead control was 50%. Addition of 1/4 oz/A Telar to the mixture increase seedhead control to 65% comparing 8 different dates of application.

Manage was most effective in 1987 during a very narrow window in the first week of May. Applications before May 1 and after May 5 were less effective.

Addition of Oust to the combination with Manage also increased effectiveness (Table 22). With Oust, 1/8 oz/A appeared to give optimal results. In side-by-side comparisons, Manage + Telar and Manage + Oust combinations gave similar results although the combination with Oust was consistently more effective (Table 22).

Side-by-side comparisons of the Manage (4 oz/A) + Telar (1/4 oz/A) and of the Embark (1/4 lb/A) + Telar (1/4 oz/A) according to Schedule B in combination with 2,4-D amine and surfactant also were carried out in eight trials (2 early, 4 mid-season and 2 late). These results are summarized in Table 23. Overall the Embark + Telar + 2,4-D + Surfactant gave 90% control of fescue seedheads in these trials as in past years. In contrast, the combination of Manage + Telar + 2,4-D + Surfactant gave only 70% control of fescue seedheads which was very near the overall average of 65% control of Table 21. Only with the two mid-season applications

Table 22. Comparisons of Manage + Telar and Manage + Oust combinations on seedhead formation in fescue. 1987 Rate and date trials. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1987		Manage + Telar (oz/acre)	Manage + Oust (oz/acre)	Fescue seedheads	
Applica- tion Date	Evalua- tion Date			Per ft ²	Height*
May 12	July 15	Control		17 \pm 1	42 \pm 4
		3 oz + 1/8 oz		9 \pm 3	30 \pm 1
		6 oz + 1/4 oz		10 \pm 1	28 \pm 1
			3 oz + 1/16 oz	9 \pm 3	29 \pm 1
			6 oz + 1/8 oz	6 \pm 2	29 \pm 1
May 12	June 5	Control		11 \pm 1	35 \pm 1
			4 oz	3 \pm 1	23 \pm 1
			4 oz + 1/32 oz	3 \pm 1	18 \pm 1
			4 oz + 1/16 oz	3 \pm 1	18 \pm 2
			4 oz + 3/32 oz	3 \pm 1	17 \pm 2
			4 oz + 1/8 oz	2 \pm 1	16 \pm 2
			4 oz + 5/32 oz	1 \pm 1	17 \pm 2
			4 oz + 3/16 oz	2 \pm 1	17 \pm 1
May 13	June 2	Control		11 \pm 1	34 \pm 2
		6 oz + 1/4 oz		5 \pm 3	17 \pm 2
			6 oz + 1/8 oz	4 \pm 0	16 \pm 3

* Height in inches

Table 23. Comparison of Embark + Telar and Manage + Telar combinations in side-by-side comparisons. Eight tests were applied (April 20, April 24, April 30, May 1, May 4, May 7, May 11 and May 13) and averaged in these comparisons. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

Embark	Amount per acre*				Fescue seedheads	
	Manage	Telar	X-77	2,4-D amine	Per ft ²	Height (inches)
-	-	-	-	-	15.0 \pm 2.0	42 \pm 5
1/4 lb	-	1/4 oz	0.25%	2 lb	1.5 \pm 2.1	21 \pm 3
-	4 oz	1/4 oz	0.25%	2 lb	4.5 \pm 3.5	24 \pm 6

* All rates are in pounds or ounces per acre of active materials except for X-77 which is percent by volume of the total spray mixture.

Table 24. Dates of seedhead formation. IN-126 test area, West Lafayette (Tippecanoe County), Indiana.

Year	Approximate date of first seedhead emergence ^a	
	Bluegrass	Fescue
1983	April 28	May 8
1984	May 3	May 15
1985	April 27	May 15
1986	April 30	May 12
1987	April 25	May 5

^a Determined by back extrapolation from the rate of appearance of early seedheads.

were the treatmentseivalent. Both early and late, the Embark combination was decidedly superior in inhibition of fescue seedheads,

While the Embark + Telar combination provides better control of fescue seedheads, the appearance of the plots treated with Manage + Telar also was often acceptable since those seedheads that formed were short (Table 23). Only in about 4 of approximately 20 trials (20% of the time) did the Manage + Telar combination fail to reduce seedhead height.

Establishment of the Embark + Telar "window"

The time course of grass growth of both fescue and of bluegrass has been recorded in the Lafayette area (Tippecanoe County) during each year of the project. Results from 1983-1985 have been reported previously. Those from 1986 and 1987 are recorded here and summarized in Table 24 (page 41). Seedheads in bluegrass and in fescue first appear within a 10 day period between April 25 and May 5 for bluegrass and between May 5 and May 15 for fescue. The beginning of emergence of fescue seedheads marks the absolute end of the Embark window.

Growth curves are illustrated for bluegrass and fescue both in 1987 (Fig. 5) and in 1986 (Fig. 6). Results from 1987 (Fig. 5) are most typical. Greenup begins in late March and growth begins to accelerate to the first of May and then grows steadily at a rate of about 1 inch per day during the month of May or until seed heads are fully formed. Fescue seedheads reach a height of about 45 inches whereas bluegrass seedheads are shorter at about 24 inches. In 1986 (Fig. 6), greenup occurred at about the same time as in 1987 and growth began to accelerate to about April 12. This was followed by a period of cold weather when all growth was stopped until about the end of April. It was during this time that problems with Embark + Telar toxicity were experienced.

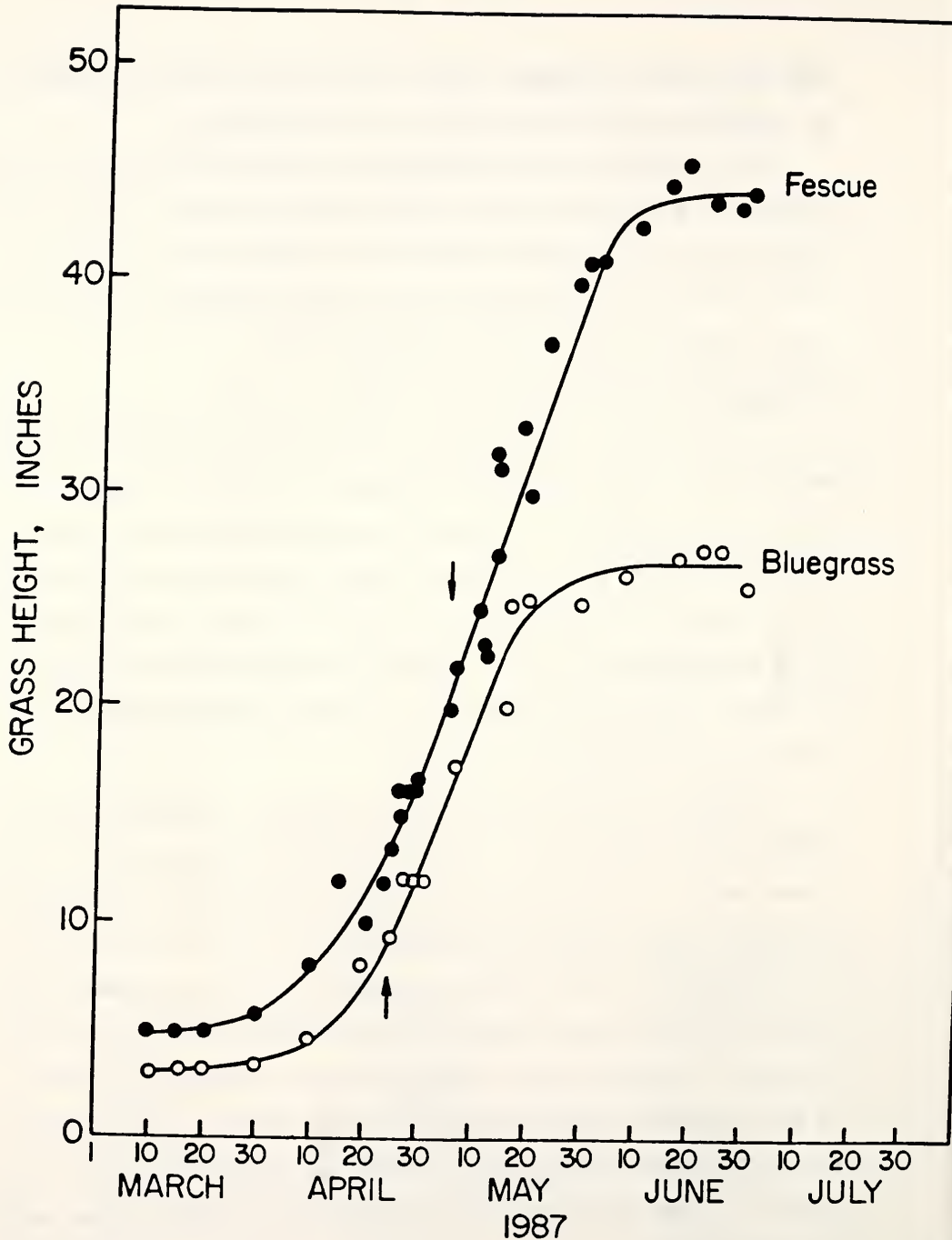


Fig. 5. Growth of fescue (●) and bluegrass (○) during the 1987 season. IN-126 test area. West Lafayette, Indiana (Tippecanoe County). Arrows indicate the first appearance of seedheads.

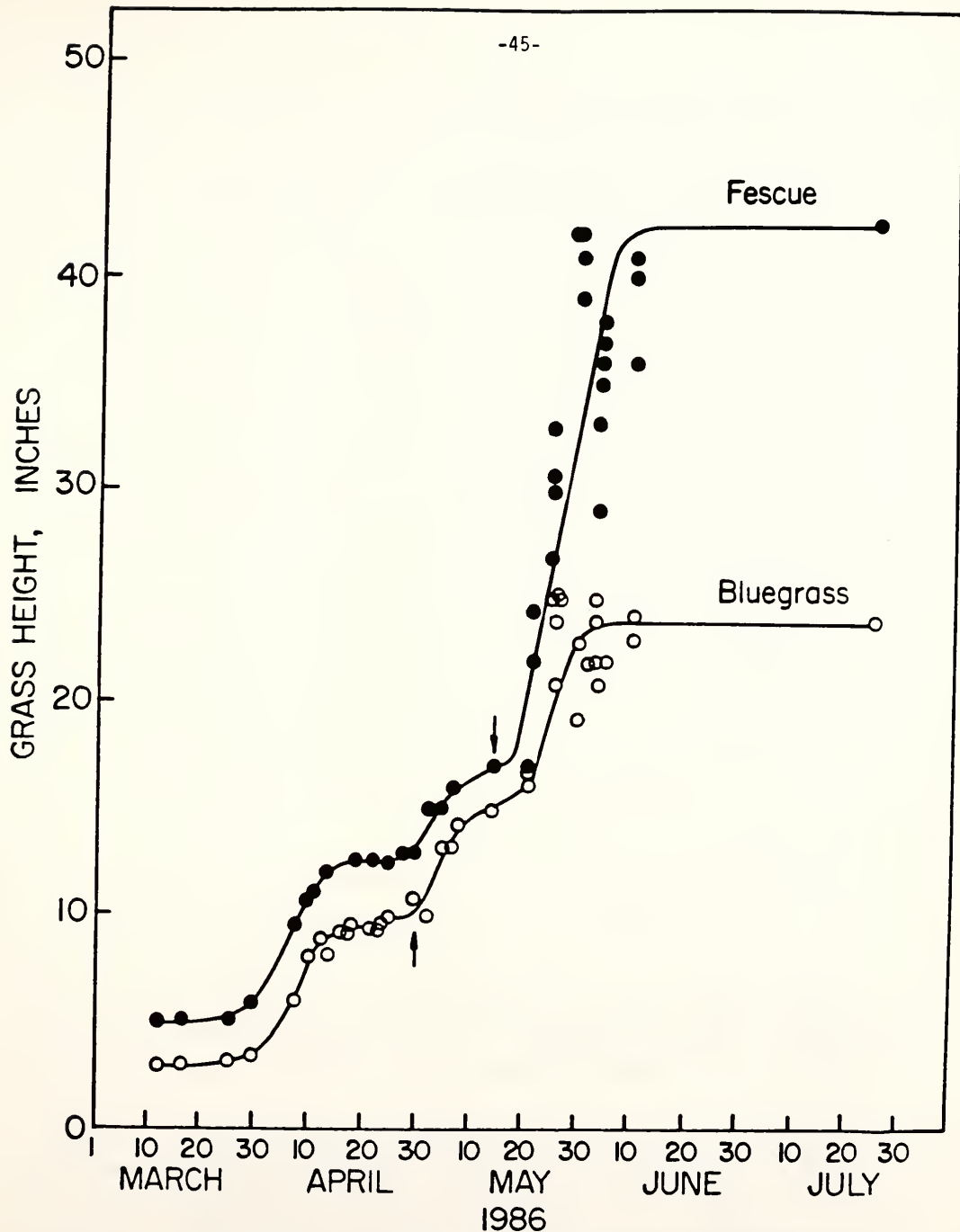


Fig. 6. Growth of fescue (●) and bluegrass (○) during the 1986 season. IN-126 test area. West Lafayette, Indiana (Tippecanoe County). Arrows indicate the first appearance of seedheads. The season was atypical in that periods of rapid growth were interrupted by periods of slow growth due to cold weather.

While the date of emergence of seedheads determines one end of the application window for the Embark + Telar combination, the beginning of rapid growth marks the other (Fig. 7). When percent seedhead suppression in fescue is graphed at different times of application of the combination of 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine + surfactant (Schedule B), maximum effectiveness of the treatment is reached at the beginning of April and extends through the first week of May (solid symbols in Figure 7). Similar results were obtained with 1/8 lb/A Embark + 1/8 oz/A Telar + 2 lb/A 2,4-D amine + surfactant (Schedule C) except that seed head control was about 90% (open symbols in Figure 7) compared to nearly 100% for schedule B.

The relatively extended window for the Embark + Telar combinations of approximately 5 weeks contrasts with the relatively narrow window for the Manage + Telar combination determined in 1987 (Table 21) to be on the order of one week in duration (Fig. 8). This window coincided approximately with the successful application times for Manage in 1986 (Appendix I).

Discussion

This study demonstrates the practical use of combinations of chemicals to reduce or prevent growth of grass and weeds along roadsides so that the need for mechanical mowing is reduced. Embark remains as the most reliable and effective primary retardant for the mixture and with the greatest margin of safety. Among its several advantages are no appreciable inhibition of root growth.

By mixing Embark with various additives, effectiveness is increased and costs are reduced. Among the most effective of the additives is Telar. At just fractions of an ounce per acre, this material when mixed with Embark reduced or eliminates seedheads in fescue using amounts of chemicals whose costs are may be less than that of a single conventional mowing cycle.

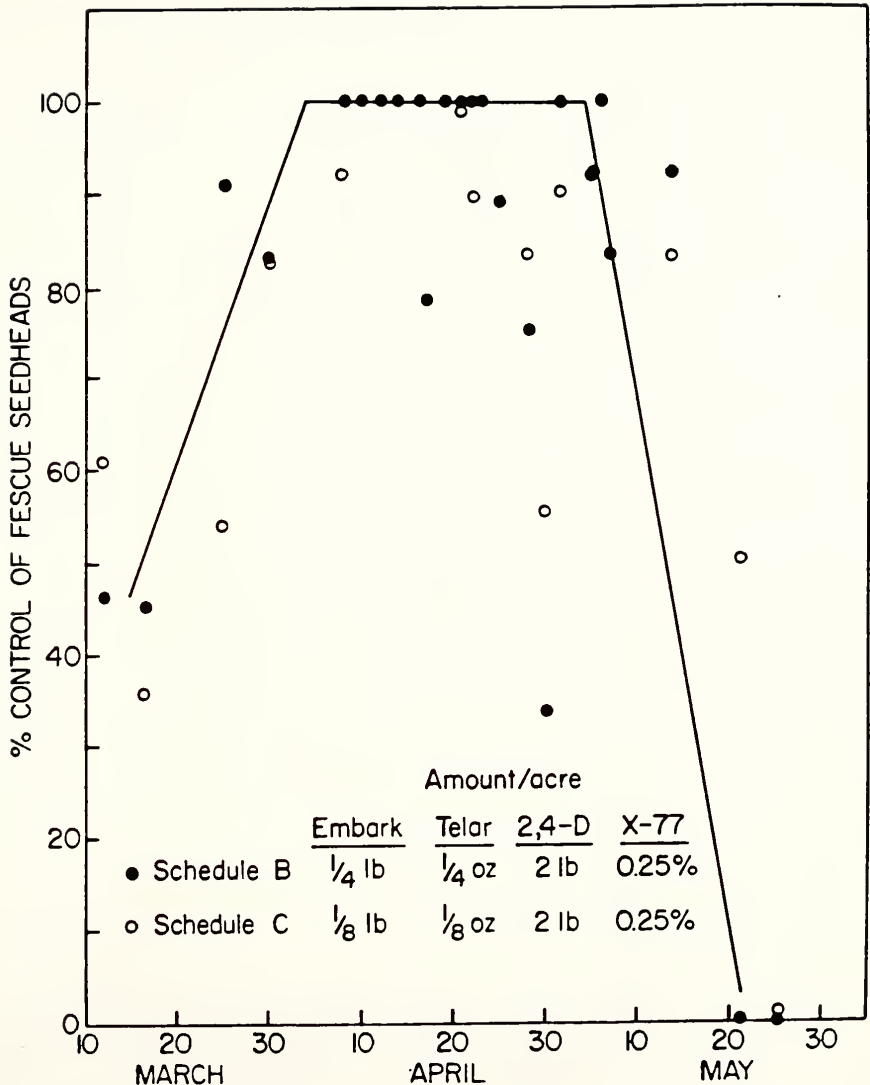


Figure 7. Seedhead suppression in fescue comparing different dates of application in 1986. Schedule B (1/4 lb Embark + 1/4 oz Telar + 2 lb 2,4-D amine + surfactant) (closed symbols) and schedule C (1/8 lb Embark + 1/8 oz Telar + 2 lb 2,4-D amine + surfactant) (open symbols) are compared. The application window for the Embark + Telar combination extends from the beginning of April to about the end of the first week of May when seedheads first begin to form.

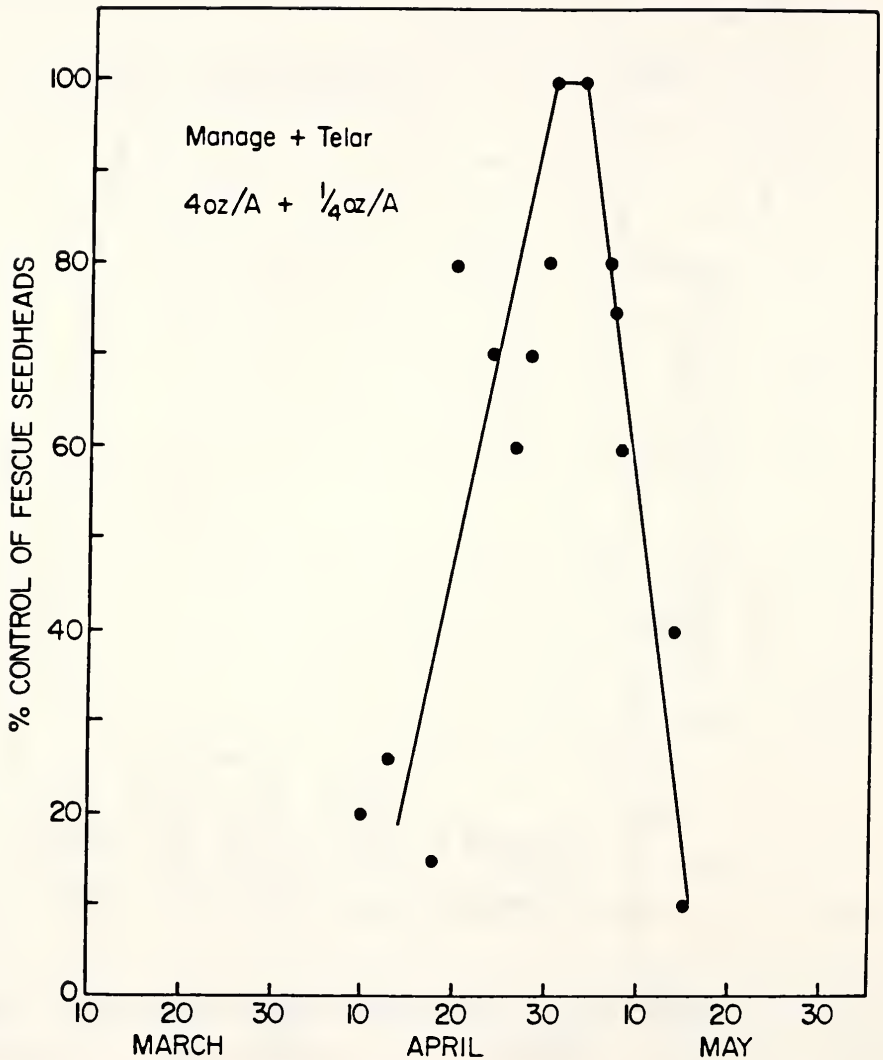


Figure 8. Seedhead suppression in fescue comparing different dates of application of Manage (3-6 oz/A) plus Telar (1/4 oz/A) in a mixture containing 2 lb/A of 2,4-D amine and surfactant X-77 (0.25% by volume of the total spray mixture) in 1987. A very narrow application window of about 1 week was observed.

The effect of the surfactant is to increase effectiveness of both the Embark and of the 2,4-D amine. This effect is due to enhanced penetration of these materials through the foliage of the treated vegetation. However, foliar uptake is not the only route of entry of plant growth regulators into vegetation. It is apparent, as well, that these materials can enter through the root system. Root uptake via the soil would not be expected to be influenced by the presence or absence of surfactants, however.

Schedule B, with the addition of Telar as additive to the Embark + Surfactant + 2,4-D mixture, has proven very effective in the control of seedheads in fescue and in general vegetation management on improved dual lane and interstate highways. Control of fescue seedheads is nearly complete. For most species, weed control is also better than 90% and due to the inclusion of Telar in the mixture, which is very effective for control of wild carrot. Schedule B has been thoroughly tested in the field for four years under actual use conditions in several locations and is the proven reliable standard against which other treatments must now be judged. Cost is comparable to one mowing cycle.

Schedule C or some variation of schedule C is expected to be even more cost effective than schedule B. However, with schedule C, field experience is much more limited and additional testing will be required. Small plot results have been most encouraging. Schedule C has given results comparable or superior to 4 oz of Manage + 1/4 oz Telar (in combination with 2,4-D and surfactant). However, material costs for the Manage + Telar combination would be on the order of \$18.00/A compared to about \$9.00/A for schedule C.

With either schedule B or schedule C, spring applications only are recommended. The materials can be applied in the fall for seedhead control the following spring but much higher rates are required and the fall applications have not proven to be economical. With both schedules B and C, the seedheads

and grass remain after spraying essentially the way they were at the time of application. Vegetation growth will resume after a time but seed heads once suppressed will not reform until the following spring. Thus, with both schedules B and C, the materials may be applied at any time from green-up until the seedheads just emerge from the boot. This constitutes an application "window" of about 5 weeks.

A large segment of work was involved with the development of a new mixture of materials for use on secondary roads. The approach taken was to screen for some combination that would control seedhead formation in smooth brome, a problem on secondary roads not encountered on Interstates. Additionally the material was to have pre-emergence activity against late-germinating weeds and annual grasses. Among the most effective materials selected initially were compounds that by themselves were phytotoxic but without true growth retardant action. One of the most effective was the addition of Poast with or without crop oil to Schedule B. The margin of safety of the mixture, however, was quite narrow and potential toxicity remains as a major concern. Field testing of this material, however, is expected to continue.

A major important new finding was that a combination of Embark plus Garlon in combination with Telar was very effective in suppression of seedheads in smooth brome and orchardgrass without apparent toxicity to bluegrass or to other turf species. It may not be necessary to add 2,4-D to this mixture as the Garlon + Telar combination may provide sufficient weed control by themselves. This combination is expected to enter initial testing for implementation in 1988.

Laboratory studies were equally rewarding. Significant progress was recorded in efforts of long standing to identify the specific plant molecules that combine with growth retardants and herbicides. These findings have facilitated development of new assays for growth regulators and have aided in

evaluations of environmental safety. Perhaps the greatest utility of the new findings has been the rapid development of better and more effective combinations of plant growth regulating materials. Since it is now possible to combine agents in a test tube, much larger numbers of combinations can be evaluated in a much shorter time and at lower cost.

Recommendations

In 1983, 1/2 lb/A Embark + 0.5% surfactant + 2 lb/A 2,4-D amine were tested successfully using commercial applicators and application equipment (Schedule A, Table 25). In 1984-1987, a spring application of 1/4 lb/A Embark + 1/4 oz/A Telar + 2 lb/A 2,4-D amine and 0.25% surfactant were tested and gave 90% control of seedheads of both fescue and bluegrass and of broadleaf weeds (Schedule B, Table 25) at a cost of \$5.00 per acre less than Schedule A. Even greater cost savings may be possible with Schedule C (material costs of less than \$10.00/A). When used on Interstates or dual lane roads, the sprayed areas do not require mowing until late in the season when native prairie species such as purple top form seedheads. Estimates of costs of materials for the recommended schedules are provided in Table 26 and recommended application dates determined experimentally are provided in Table 27.

On secondary roads, the treatments were much less effective due to smooth brome seedheads which were not controlled and the growth of late-germinating weeds (such as velvet leaf) and annual grasses which tended to dominate such narrow right-of-way roads adjacent to cropped fields late in the growing season. For use on these roads, a series of alternative treatments have been developed (Table 28) for implementation testing. Each of these treatments will require considerable further testing, to include environmental impact assessments, before definite recommendations will be possible. These schedules may also be combined with pre-emergence herbicides such as Balan or Surflan to enhance control of the late-germinating annual weeds and grasses.

Table 25. Recommended program of chemical mowing for roadside vegetation management in Indiana. Each of the following schedules has been tested in at least three successive years in at least 3 different locations within the state under actual use conditions with consistent and reproducible results. The 3 schedules normally give equivalent results. Schedule A is the most costly but has the greatest safety margin. Schedule C is the least costly but seedhead control in fescue may drop below 90% with some early applications. Schedule B is, at present, considered as the most cost-effective compromise for general highway use.

Materials: Embark (mefluidide) Plant Growth Regulator containing 2 lb active mefluidide per gallon. Telar (chlorsulfuron) concentrate containing 75% active material. 2,4-D amine form concentrate containing 4 lb/gallon acid equivalent (Ester formulations of 2,4-D are not recommended due to possible environmental hazards). X-77 or WK Surfactant concentrate.

Rate:

 Schedule A: 1/2 lb/A Embark (as mefluidide) + 0.25% X-77 + 2 lb/A of 2,4-D amine.

Materials are mixed at the rate of approximately 2.3 gallons of Embark plus 1/4 gallon of X-77 plus 1 1/2 gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

 Schedule B: 1/4 lb/A Embark (as mefluidide) = 1 pint/A + 1/4 oz/A Telar + 0.25% X-77 + 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately 2 1/2 pints of Embark plus 5/8 oz Telar (reduction to 1/2 oz would seem feasible on the basis of 1986 and 1987 test results) plus 1/4 gallon of X-77 plus 1 1/2 gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

 Schedule C: 1/8 lb/A Embark (as mefluidide) = 1/2 pint/A + 1/8 oz/A Telar + 0.25% X-77 + 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately 1 1/4 pints of Embark plus 5/16 oz of Telar (reduction of 1/4 oz would seem feasible on the basis of 1986 and 1987 test results) plus 1/4 gallon of X-77 plus 1 1/2 gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule of Application: Recommended for application the spring only. For schedules A and B, apply as the grass begins to green and grow at the beginning of April until just before the emergence of seedheads from the boot at the end of the first week of May. Application of schedule C should begin approximately 10 days later on or about April 10 with termination the same as schedule B. With schedule A, termination should be about 1 week earlier at the beginning of May. These dates are for the central 1/3 of the state. For the Northern 1/3, one week may be added. For the Southern 1/3, one week may be subtracted. These dates are summarized in tabular form in Table 17. Comparable cost of materials comparisons are summarized in Table 26.

Table 26. Approximate costs of materials for comparisons for the recommended program of chemical mowing for vegetation management along Indiana roadsides:

Based on: Telar \$14.50/oz; Embark \$32.00/lb; 2,4-D amine \$1.70/lb; Surfactant \$10.00/gallon.

Schedule	Material cost per acre				Total
	Embark	Surfactant	Telar	2,4-D Amine	
A	\$16.00	\$1.00	\$ 0.00	\$3.40	\$20.40
B	8.00	1.00	3.00	3.40	15.40
C	4.00	1.00	1.50	3.40	9.90

Table 27. Dates of application for the recommended program of chemical mowing for vegetation management along Indiana roadsides.

Schedule	Southern 1/3		Central 1/3		Northern 1/3	
	Begin	End	Begin	End	Begin	End
Schedule A	March 25	April 24	April 1	May 1	April 8	May 8
Schedule B	March 25	May 1	April 1	May 8	April 8	May 15
Schedule C	April 3	May 1	April 10	May 8	April 17	May 15

These dates should be regarded as approximate and the application window may vary as much as 7 to 10 days in length depending upon the season and particular weather conditions of any given year.

Table 28. Program of alternative treatments for use on secondary roads. While each of the following schedules has received limited testing under actual use conditions, further testing is required before definite recommendations will be possible.

Schedule SR-1. 1/4 lb/A Embark (as mefluidide) + 1/4 oz/A Telar + 1/2 lb/A Garlon-4 + 0.25% surfactant (to be tested with or without the inclusion of 1/2 lb/A 2,4-D amine)

Materials are mixed at the rate of approximately 2 1/2 pints of Embark plus 5/8 oz (1/2 oz) Telar plus 5/16 gallons (2 1/2 pints) Garlon-4 plus 1/4 gallon X-77 (with or without 3/8 gallon (3 pints) of 2,4-D amine) in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule SR-2. 1/4 lb/A Embark (as mefluidide) + 1/4 oz/A Telar + 1/2 lb/A Poast (down to 0.3 lb/A) with or without 1 gallon/A of crop oil + 0.25% surfactant + 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately 2 1/2 pints of Embark plus 5/8 oz (1/2 oz) Telar plus 2 1/2 quarts of Poast concentrate (down to 1 1/2 quarts) with or without 2 1/2 gallons crop oil + 1/4 gallon X-77 + 1 1/2 gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule SR-3. 4 oz/A Manage + 1/4 oz/A Telar + 1/2 lb/A Garlon-4 + 0.25% surfactant (to be tested with or without the inclusion of 1/2 lb/A 2,4-D amine).

Materials are mixed at the rate of approximately 1/4 lb (4 oz) Manage plus 5/8 oz (1/2 oz) Telar plus 5/16 gallon (2 1/2 pints) Garlon-4 plus 1/4 gallon X-77 (with or without 3/8 gallon (3 pints) of 2,4-D amine) in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule SR-4. 4 oz/A Manage + 1/8 oz/A Oust + 1/2 lb/A Garlon-4 + 0.25% surfactant (to be tested with or without the inclusion of 1/2 lb/A 2,4-D amine).

Materials are mixed at the rate of approximately 1/4 lb (4 oz) Manage plus 5/16 oz (1/4 oz) Oust plus 5/16 gallon (2 1/2 pints) Garlon-4 plus 1/4 gallon X-77 (with or without 3/8 gallon (3 pints) of 2,4-D amine) in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule of Application. Schedule SR-1 and Sr-2 should follow the same dates of application as Schedule B of Table 27 and can be applied any time between greenup and the beginning of growth until the seedheads are formed in the boot. Schedule SR-3 and Sr-4 should be delayed in its application until the 3rd week of April for Central Indiana. For the Northern 1/3 of the state, applications may be delayed for one week longer while in the Southern 1/3 of the state, the applications may be begun and ended one week earlier.

Pre-emergence herbicides (Balan, 3 lb/A; Surflan, 2 quarts/A) may be added to each of the above schedules to enhance control of late-germinating annual weeds and grasses.

Additionally, a series of alternative treatments for use on Interstates and dual lane roads has been developed as well (Table 29). Each of these schedules has received limited testing under use conditions as well but further testing is recommended before definite recommendations are made. Again, testing should include environmental assessments. Whether or not any of these treatments will prove more cost effective than either Schedule B or C (Table 25) must await further testing.

Materials costs for comparisons of the alternate programs of chemical mowing for vegetation management on both secondary roads (Table 28) and the Interstate/dual lane roads (Table 29) are given in Table 30. Schedules D and E, if proven safe and effective on implementation, would be considerably less expensive than the comparable schedules B and C which they would replace (Table 25). Schedules F and G have given seedhead control in fescue comparable to Schedule C of Table 25 and are, at present, twice as expensive. However, further cost reductions may be possible as various combinations involving Manage Industrial Growth Retardant are explored.

All of the combinations for secondary roads are more expensive than the least-expensive Schedule C for Interstates (Table 30). However, Schedule SR-1, involving Garlon-4, is of quite reasonable cost and its implementation, if effective on secondary roads, would provide considerable savings compared to current maintenance operations involving mechanical mowing both in terms of reduced labor requirements and reduced equipment costs.

Table 29. Program of alternative treatments for use on Interstates and dual lane roads. Each of the following schedules has received limited testing under use conditions. However, further testing is recommended before definite recommendations will be possible to include a detailed environmental impact assessment.

Schedule D. $1/4$ lb/A Embark (as mefluidide) = 1 pint/A + $1/8$ oz/A Oust + 0.25% X-77 + 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately 2 $1/2$ pints of Embark plus $5/16$ oz of Oust (or even as low as $1/4$ oz) plus $1/4$ gallon of X-77 plus 1 $1/2$ gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule E. $1/8$ lb/A Embark (as mefluidide) = 1 pint/A + $1/16$ oz/A Oust + 0.25% X-77 + 2 lb/A 2,4-D amine

Materials are mixed at the rate of approximately 2 $1/2$ pints of Embark plus $5/32$ oz of Oust ($1/8$ oz of Oust) plus $1/4$ gallon of X-77 plus 1 $1/2$ gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule F. 4 oz/A Manage + $1/4$ oz/A Telar + 0.25% X-77 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately $1/4$ lb (4 oz) of Manage plus $5/8$ oz ($1/2$ oz) Telar plus $1/4$ gallon X-77 plus 1 $1/2$ gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule G. 4 oz/A Manage + $1/8$ oz/A Oust + 0.25% X-77 + 2 lb/A 2,4-D amine.

Materials are mixed at the rate of approximately $1/4$ lb (4 oz) Manage plus $5/8$ oz ($1/2$ oz) Telar plus $1/4$ gallon X-77 plus 1 $1/2$ gallons of 2,4-D amine in 100 gallons of water. The mixture is applied at the rate of 40 gallons per acre.

Schedule of Application: Recommended for application in the spring only. For Schedule D, apply as the grass begins to green and grow at the beginning of April until just before the emergence of seedheads from the boot at the end of the first week of May. Application of schedule E should begin approximately 10 days later on or about April 10 with termination the same as schedule D. With schedules F and G, application should be delayed until the 3rd week of April for best results. For the Northern $1/3$ of the state, applications may be delayed for one week longer than the dates given above while in the Southern $1/3$ of the state, the applications may be begun and ended one week earlier.

Table 30. Approximate costs of materials for comparisons of the alternative programs of chemical mowing along Indiana roadsides.

Based on: Embark \$32.00/lb; Telar \$14.50/oz; Oust \$8.75/oz; Poast \$25.00/lb; Crop Oil \$3.00 /gallon; Manage \$44.00/lb; Garlon-4 \$15.00/lb; 2,4-D amine \$1.70/lb; X-77 surfactant \$10.00/gallon.

Schedule	Material cost per acre								2,4-D		Total
	Embark	Manage	Telar	Oust	Garlon-4	Poast	Crop Oil	X-77	Amine		
D	\$8.00	-	-	\$1.10	-	-	-	\$1.00	\$3.40	\$13.50	
E	4.00	-		0.55	-	-	-	1.00	3.40	8.95	
F	-	\$11.00	\$3.00	-	-	-	-	1.00	3.40	18.40	
G	-	11.00	-	\$1.10	-	-	-	1.00	3.40	16.50	
SR-1	8.00	-	3.00	-	\$ 7.50	-	-	1.00	-*	19.50	
SR-2	8.00	-	3.00	-	-	\$12.50	3.00	1.00	3.40	30.90	
SR-3	-	11.00	3.00	-	7.50	-	-	1.00	-*	22.50	
SR-4	-	11.00	-	1.10	7.50	-	-	1.00	-*	20.50	

* Final recommendation may include 1/2 lb/A 2,4-D amine to increase the cost of materials by about \$0.80.

** Material costs may drop as low as \$21.00 depending on final rates of Poast and 2,4-D amine required. The \$21.00 figure would be based on 1/4 lb/A Poast and 1/2 lb/A 2,4-D amine.

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APPENDICES

Appendix I 1986

SUMMARY OF MAJOR FINDINGS

Appendix II 1987

SUMMARY OF MAJOR FINDINGS

A P P E N D I X I

1986

SUMMARY OF MAJOR FINDINGS

1986

SUMMARY OF MAJOR FINDINGS

Summaries of major findings for project years 1983 to 1985 have already been the subject of published reports and will not be repeated here. Additional brief discussions of findings and summations are provided with some of the tables and figures that follow together with procedural details not included in the main body of the report.

1. More than 500 individual research plots were established and evaluated in 1986. The results of those tests are recorded in the tables that follow.
2. A major undertaking was detailed rate and date studies comparing different amounts of Embark and Telar in various combinations.
3. The date of emergence of seedheads determined one end of the application window for the Embark + Telar combination and the beginning of rapid growth marks the other. With both 1/4 lb/A Embark + 1/4 oz/A Telar and 1/8 lb/A Embark + 1/8 oz Telar (both in combination with 2 lb/A of 2,4-D amine and surfactant) (Table 1), maximum effectiveness is reached at the beginning of April and extended through the first week of May. This gives an application window of nearly 5 weeks (Table 1).
4. In all 5 years of the study, 1/4 oz/A of Telar plus 1/4 lb/A of Embark were equivalent to 1/2 lb/A of Embark alone.
5. Nearly equivalent results were obtained with a combination of 1/8 lb Embark + 1/8 lb Telar as compared to 1/4 lb Embark + 1/4 lb Telar (per acre) (Tables 1 and 2).
6. When the ratio of Embark and Telar was held constant (Table 2). Embark 1/4 lb/A + Telar 1/4 oz/A, Embark 3/16 lb/A + Telar 3/16 oz/A¹, and Embark 1/8 lb/A + Telar 1/8 oz/A produced equivalent results in the mixture. Embark 3/32 lb/A + Telar 3/32 oz/A and Embark 1/16 lb/A + Telar 1/16 oz/A caused both reductions in seedhead numbers and in seedstalk heights but insufficient to meet highway

requirements. Six different dates of application between April 14 and May 21 were evaluated in making these conclusions.

7. With Embark constant at 1/4 lb/A, Telar was varied between 1/32 oz/A and 1/4 oz/A. With 1/4 lb/A of Embark, the amount of Telar could not be reduced below 1/8 oz/A without loss of effectiveness. However, 1/8 oz/A, 3/16 oz/A and 1/4 oz/A were all equivalent when mixed with 1/4 lb/A Embark. These conclusions were based on four different dates of application in 1986 (Table 3).
8. It was possible to combine various pre-emergence materials with Schedule B to increase its effectiveness for use on secondary roads (Tables 4-14).
9. Among the more effective materials for control of annual grasses such as giant foxtail and for seedhead control in smooth brome was Poast (Tables 4, 6, 7, 11 and 13). As little as 0.25 lb/A of Poast was required and as much as 1 lb/A was tolerated by fescue (Table 14).
10. An excellent pre-emergence material for control of foxtail and other annual grasses for addition to Schedule B was Balan (Table 4).
11. Also effective was Surflan (Table 5) although no effect on smooth brome seedheads was noted.
12. Roundup added to the mixture was tested for ability to reduce seedheads in smooth brome but was ineffective (Tables 9, 10 and 12). Also ineffective were dinitrophenol (Table 8) and Premerge (Tables 9 and 10). Dinitrophenol appeared to have an effect in some experiments, but the response was not reproducible.
13. Balan added to schedule B was not only an effective pre-emergence grass agent but also appears to reduce seedheads in smooth brome (Tables 4 and 13).
14. ACP 1900 was evaluated in combination with Embark and Telar both as a primary retardant and as an additive. While the material was quite active, it appeared to offer no advantage over either Embark or Telar (Table 15).

15. On I-70 Schedule B and schedule C were essentially equivalent (Table 16). Weed control was excellent and estimated to be greater than 87%. Had it not been for late flowering prairie species such as fall panicum, yellow foxtail and purpletop, mowing would not have been required.
16. An initial implementation test comparing Poast and Poast + crop oil (Table 17) showed best control of seedheads in smooth brome with the treatment consisting of 1/4 lb Embark + 0.5 lb Poast + 1 quart crop oil/acre (Table 18).
17. Addition of crop oil to the combination with Poast greatly increased its effectiveness (Tables 11 and 18).
18. Balan 3 lb/A gave best control of foxtail and other late germinating annual grasses in the implementation test (Table 19).
19. A Monsanto product, Manage (Mon 8000) was evaluated for the first time in test plots near Indianapolis applied by Monsanto together with Clyde Mason (IDOH). The material applied on April 10 and on April 20 was effective in seedhead control at rates of 4 or 6 oz/A (Table 20).
20. The effectiveness of Manage (Mon 8000) was enhanced by combination with Telar (1/4 oz/A) or Oust (1/8 oz/A or 1/4 oz/A). With Oust, the 1/4 oz/A rate appeared superior to the 1/8 oz/A rate. These combination materials were selected for a detailed evaluation in 1987 and these findings are provided in Appendix II of this report.

Table 1. Embark + Telar combinations, 1986 rate and date study. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1986 Applica- tion Date	Evalua- tion Date	Embark (1b) + Telar (oz) Rate/acre	Fescue Initial Height*	Seedheads		Bluegrass Initial Height*	Seedheads	
				Per ft ^c	Height*		Per ft ^c	Height*
March 12	May 25	Control	5	13 + 4	33 + 6	3	4 + 1	24 + 1
		1/4 1b + 1/4 oz		7 + 4	28 + 4		2 + 2	20 + 4
		1/8 1b + 1/8 oz		5 + 1	25 + 3		3 + 3	22 + 2
March 17	May 25	Control	5	11 + 2	30 + 1	3	4 + 2	24 + 3
		1/4 1b + 1/4 oz		6 + 4	25 + 3		4 + 3	19 + 4
		1/8 1b + 1/8 oz		7 + 2	21 + 3		2 + 1	21 + 1
March 25	May 25	Control	5	11 + 1	27 + 2	3	4 + 1	23 + 3
		1/4 1b + 1/4 oz		1 + 0	21 + 1		2 + 2	19 + 0
		1/8 1b + 1/8 oz		5 + 1	21 + 2		2 + 1	18 + 1
April 1	May 25	Control	6	12 + 0	25 + 1	3.5	3 + 1	25 + 1
		1/4 1b + 1/4 oz		2 + 2	20 + 1		1 + 2	14 + 3
		1/8 1b + 1/8 oz		2 + 1	18 + 1		1 + 1	18 + 1
April 8	May 25	Control	9.5	12 + 0	27 + 3	6	4 + 1	24 + 2
		1/4 1b + 1/4 oz		0 + 0	-		3 + 3	16 + 2
		1/8 1b + 1/8 oz		1 + 1	15 + 1		3 + 2	18 + 4
April 10	June 1	Control	10.5	12 + 1	48 + 8	8	2 + 0	28 + 3
		1/4 1b + 1/4 oz		0 + 0	-		0 + 1	8 + 3
April 12	June 1	Control	11	10 + 2	42 + 6	9	3 + 1	34 + 2
		1/4 1b + 1/4 oz		0 + 0	-		1 + 1	18 + 0
April 14A	May 21	Control	11.5	4 + 1	17 + 1	8	0 + 1	(16)
		1/4 1b + 1/4 oz		0 + 0	-		1 + 1	17 + 2
		1/8 1b + 1/8 oz		0 + 0	-		1 + 1	14 + 1
April 14B	May 25	Control	11	14 + 2	31 + 2	8	8 + 3	25 + 4
		1/4 1b + 1/4 oz		0 + 0	-		2 + 2	14 + 4
		1/4 1b + 1/8 oz		0 + 0	-		2 + 1	14 + 2
April 16	June 1	Control	12	12 + 1	41 + 1	9	1 + 1	23 + 3
		1/4 1b + 1/4 oz		0 + 1	11 + 2		1 + 0	11 + 0
April 17	May 22	Control	12	9 + 2	24 + 1	9	3 + 1	12 + 1
		1/4 1b + 1/4 oz		2 + 2	11 + 3		0 + 0	-
April 19	June 1	Control	12.5	11 + 1	42 + 5	9.5	2 + 2	24 + 2
		1/4 1b + 1/4 oz		0 + 0	-		1 + 1	11 + 2
April 21	May 25	Control	11	10 + 2	25 + 2	9	3 + 1	21 + 1
		1/4 1b + 1/4 oz		0 + 0	-		2 + 1	11 + 2
		1/8 1b + 1/8 oz		0 + 0	-		2 + 1	16 + 2

* Height in inches

Table 1. Continued. Embark + Telar combinations, 1986 rate and date study. All treatments were in combination with 2,4-D amine (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

1986 Applica- tion Date	Evalu- ation Date	Embark (lb) + Telar (oz) Rate/acre	Fescue			Bluegrass		
			Initial Height*	Seedheads Per ft ²	Height*	Initial Height	Seedheads Per ft ²	Height*
April 22	June 4	Control	12	9 + 2	33 + 5	9	4 + 3	22 + 4
		1/4 lb + 1/4 oz		0 + 1	(21)		1 + 1	(24)
		1/4 lb + 1/8 oz		1 + 1	(22)		1 + 1	(17)
April 23	June 1	Control	12.5	10 + 3	39 + 3	9.5	4 + 2	27 + 2
		1/4 lb + 1/4 oz		0 + 0	-		2 + 2	14 + 0
April 25	May 30	Control	12.5	9 + 3	36 + 0	10	2 + 1	19 + 1
		1/4 lb + 1/4 oz		1 + 1	24 + 4		0 + 1	16 + 4
April 28	June 4	Control	13	12 + 0	37 + 1	11	1 + 1	24 + 1
		1/4 lb + 1/4 oz		3 + 3	28 + 3		2 + 1	27 + 5
		1/8 lb + 1/8 oz		2 + 0	14 + 6		1 + 1	15 + 2
April 30	June 4	Control	13	9 + 1	35 + 2	11	2 + 1	21 + 3
		1/4 lb + 1/4 oz		6 + 4	34 + 3		4 + 1	23 + 2
		1/4 lb + 1/8 oz		4 + 3	33 + 3		1 + 1	19 + 1
May 2	June 4	Control	15	11 + 1	36 + 1	10	3 + 1	28 + 2
		1/4 lb + 1/4 oz		0 + 1	(12)		1 + 1	12 + 0
		1/4 lb + 1/8 oz		1 + 2	(25)		1 + 1	(11)
May 5	June 10	Control	15	12 + 2	40 + 4	13	6 + 2	24 + 2
		1/4 lb + 1/4 oz		1 + 1	20 + 2		6 + 2	20 + 2
May 6	June 10	Control	15	12 + 2	41 + 3	13	6 + 2	24 + 2
		1/4 lb + 1/4 oz		0 + 0	-		6 + 2	21 + 3
May 7	June 10	Control	16	12 + 2	36 + 1	14	10 + 4	23 + 3
		1/4 lb + 1/4 oz		2 + 1	18 + 4		5 + 3	19 + 2
May 14	June 4	Control	17	12 + 0	38 + 1	15	6 + 2	25 + 3
		1/4 lb + 1/4 oz		1 + 1	(20)		3 + 1	18 + 1
		1/8 lb + 1/8 oz		2 + 1	17 + 4		2 + 1	21 + 2
May 21	June 4	Control	22	6 + 2	29 + 3	17	4 + 3	22 + 5
		1/4 lb + 1/4 oz		6 + 0	25 + 2		3 + 2	19 + 5
		1/8 lb + 1/8 oz		3 + 1	25 + 2		2 + 1	20 + 2

* Height in inches

Table 2 . Embark + Telar combinations, 1986 rate and date study, in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture)

Application date:	April 14	April 21	April 28	May 7	May 14	May 21
Evaluation date:	May 21	May 25	June 4	June 4	June 4	June 4
FESCUE SEEDHEADS/ft ²						
Control	4 ± 1	10 ± 2	12 ± 0	11 ± 1	12 ± 0	6 ± 2
E 1/4 lb + T 1/4 oz	0 ± 0	0 ± 0	3 ± 3	0 ± 0	1 ± 1	6 ± 0
E 3/16 lb + T 3/16 lb	0 ± 0	0 ± 0	2 ± 1	0 ± 0	0 ± 0	4 ± 2
E 1/8 lb + T 1/8 lb	0 ± 0	0 ± 0	2 ± 0	0 ± 1	2 ± 1	3 ± 1
E 3/32 lb + T 3/32 lb	1 ± 1	4 ± 2	3 ± 1	1 ± 1	2 ± 2	5 ± 2
E 1/16 lb + T 1/16 lb	1 ± 0	3 ± 1	5 ± 1	4 ± 3	5 ± 2	10 ± 2
FESCUE, seedhead height (in)						
Control	17 ± 1	25 ± 2	36 ± 0	37 ± 1	38 ± 1	29 ± 3
E 1/4 lb + T 1/4 oz	-	-	28 ± 3	-	(20)	25 ± 2
E 3/16 lb + T 3/16 lb	-	-	20 ± 2	-	-	22 ± 1
E 1/8 lb + T 1/8 lb	-	-	14 ± 6	(17)	17 ± 4	25 ± 2
E 3/32 lb + T 3/32 lb	(12)	18 ± 3	23 ± 3	17 ± 1	25 ± 3	25 ± 2
E 1/16 lb + T 1/16 lb	13 ± 1	16 ± 4	25 ± 2	17 ± 1	22 ± 3	26 ± 4
BLUEGRASS, seedheads/ft ²						
Control	0 ± 1	3 ± 1	1 ± 1	2 ± 1	6 ± 2	4 ± 3
E 1/4 lb + T 1/4 oz	1 ± 1	2 ± 1	2 ± 1	1 ± 1	3 ± 1	3 ± 2
E 3/16 lb + T 3/16 oz	0 ± 1	1 ± 1	1 ± 1	2 ± 1	2 ± 1	3 ± 2
E 1/8 lb + T 1/8 lb	1 ± 1	2 ± 1	1 ± 1	2 ± 2	2 ± 1	2 ± 1
E 3/32 lb + T 3/32 lb	1 ± 1	3 ± 1	0 ± 1	3 ± 2	3 ± 1	3 ± 2
E 1/16 lb + T 1/16 lb	1 ± 1	3 ± 1	1 ± 1	1 ± 1	2 ± 1	3 ± 2
BLUEGRASS, seedhead height (in)						
Control	(16)	21 ± 1	24 ± 1	21 ± 2	25 ± 3	22 ± 5
E 1/4 lb + T 1/4 oz	17 ± 2	11 ± 2	27 ± 5	12 ± 2	18 ± 1	19 ± 5
E 3/16 lb + T 3/16 oz	(11)	12 ± 1	14 ± 1	14 ± 5	20 ± 1	23 ± 0
E 1/8 lb + T 1/8 oz	14 ± 1	16 ± 2	15 ± 2	16 ± 1	21 ± 2	20 ± 2
E 3/32 lb + T 3/32 oz	13 ± 1	16 ± 2	(13)	18 ± 2	21 ± 4	23 ± 0
E 1/16 lb + T 1/16 oz	16 ± 1	17 ± 1	21 ± 3	16 ± 2	20 ± 3	20 ± 2
INITIAL HEIGHTS, inches						
Fescue	11.5	11	13	15	17	22
Bluegrass	8	9	11	13	15	17

Table 3. Embark + Telar combinations, 1986 rate and date study in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture)

Application date:	April 14	April 22	April 30	May 2
Evaluation date:	May 25	June 4	June 4	June 4
FESCUE SEEDHEADS/ft ²				
Control	14 ± 2	9 ± 2	9 ± 1	11 ± 1
E 1/4 lb + T 1/4 oz	0 ± 0	0 ± 1	6 ± 4	0 ± 1
E 1/4 lb + T 3/16 oz	0 ± 1	1 ± 1	5 ± 1	2 ± 1
E 1/4 lb + T 1/8 oz	0 ± 0	1 ± 1	4 ± 3	1 ± 2
E 1/4 lb + T 3/32 oz	2 ± 1	4 ± 2	10 ± 3	2 ± 1
E 1/4 lb + T 1/16 oz	-	3 ± 1	8 ± 4	1 ± 1
E 1/4 lb + T 1/32 oz	-	4 ± 3	10 ± 2	6 ± 4
E 1/4 lb	9 ± 3	3 ± 3	4 ± 0	2 ± 1

FESCUE, seedhead height (inches)

Control	31 ± 2	33 ± 5	35 ± 2	36 ± 1
E 1/4 lb + T 1/4 oz	-	(21)	34 ± 3	(12)
E 1/4 lb + T 3/16 oz	(15)	24 ± 1	26 ± 4	16 ± 0
E 1/4 lb + T 1/8 oz	-	(22)	33 ± 3	(25)
E 1/4 lb + T 3/32 oz	14 ± 2	25 ± 5	36 ± 2	18 ± 7
E 1/4 lb + T 1/16 oz	-	30 ± 4	35 ± 2	19 ± 6
E 1/4 lb + T 1/32 oz	-	28 ± 7	36 ± 2	31 ± 1
E 1/4 lb	23 ± 4	31 ± 5	29 ± 4	24 ± 1

BLUEGRASS, seedheads/ft²

Control	8 ± 3	4 ± 3	2 ± 1	3 ± 1
E 1/4 lb + T 1/4 oz	2 ± 2	1 ± 1	4 ± 1	1 ± 1
E 1/4 lb + T 3/16 oz	1 ± 1	1 ± 1	3 ± 1	1 ± 1
E 1/4 lb + T 1/8 oz	2 ± 1	1 ± 1	1 ± 1	1 ± 1
E 1/4 lb + T 3/32 oz	2 ± 1	0 ± 0	2 ± 1	0 ± 1
E 1/4 lb + T 1/16 oz	-	5 ± 4	2 ± 1	1 ± 1
E 1/4 lb + T 1/32 oz	-	3 ± 2	2 ± 1	3 ± 2
E 1/4 lb	3 ± 1	6 ± 2	3 ± 3	3 ± 1

Table 3 (Continued). Embark + Telar combinations, 1986 rate and date study in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture).

Application date:	April 14	April 22	April 30	May 2
Evaluation date:	May 25	June 4	June 4	June 4
BLUEGRASS, seedhead height (inches)				
Control	25 + 4	22 \pm 4	21 \pm 3	28 \pm 2
E 1/4 lb + T 1/4 oz	14 \pm 4	(24)	23 \pm 2	12 \pm 0
E 1/4 lb + T 3/16 oz	15 \pm 1	20 \pm 5	24 \pm 1	12 \pm 1
E 1/4 lb + T 1/8 oz	14 \pm 2	(17)	19 \pm 1	(11)
E 1/4 lb + T 3/32 oz	18 \pm 1	-	24 \pm 1	(19)
E 1/4 lb + T 1/16 oz	-	15 \pm 7	20 \pm 3	15 \pm 1
E 1/4 lb + T 1/32 oz	-	22 \pm 3	24 \pm 3	21 \pm 6
E 1/4	16 \pm 1	11 \pm 5	19 \pm 0	19 \pm 5
INITIAL HEIGHTS (inches)				
Fescue	11	12	13	15
Bluegrass	8	9	11	10

4. Effect of Poast and Balan in the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D amine on seedhead formation in fescue, bluegrass and smooth brome. Applied April 10, 1986. Evaluations were on June 1, 1986. IN-126 test area. 3' X 6' plots. Initial height of fescue was 10.5 in. Results are averages from three replications + standard deviations.

Amount*		Fescue Seedheads		Bluegrass Seedheads		Smooth Brome Seedheads			
Embark	X-77 Telar	2,4-D	Additive Amount	Per ft ² Height	Per ft ² Height	Per ft ² Height	Per ft ² Height		
-	-	-	-	12 ± 1	48 ± 8	2 ± 0	28 ± 3	7 ± 1	33 ± 3
1/4 lb	2.5% 1/4 oz	2 lb	-	0 ± 0	-	0 ± 1	8 ± 3	4 ± 2	29 ± 4
1/4 lb	2.5% 1/4 oz	2 lb	Poast 0.75 lb	0 ± 0	-	1 ± 1	17 ± 3	1 ± 1	25 ± 3
1/4 lb	2.5% 1/4 oz	2 lb	Balan 3 lb	0 ± 0	-	0 ± 1	18 ± 3	0 ± 0	-

* Embark = 1b/A as mefluidide; X-77 = % by volume of total spray mixture; Telar = oz/acre active material; all other = 1b/A of active materials.

5. Effect of Surflan, EL-107, Goal and Hoelon additives in the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D amine on seedhead formation in fescue, bluegrass and smooth brome. Applied April 16, 1986. Weather was cool and wet. Evaluations were on June 1, 1986. Initial height of fescue and of smooth brome was 12 in. Results are averages from three replications + standard deviations. IN-126 test area.

Amount*		Fescue Seedheads				Bluegrass Seedheads		Smooth Brome Seedheads	
Embark	X-77 Telar	2,4-D	Additive	Amount Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	12 ± 1	41 ± 1	1 ± 1	23 ± 3	9 ± 2	40 ± 6
1/4 lb	2.5% 1/4 oz	2 lb	-	0 ± 1	11 ± 2	1 ± 0	11 ± 0	2 ± 1	25 ± 3
1/4 lb	2.5% 1/4 oz	2 lb	Surflan	1 lb	1 ± 1	32 ± 10	1 ± 0	30 ± 10	9 ± 3
1/4 lb	2.5% 1/4 oz	2 lb	Surflan	2 lb	1 ± 1	15 ± 4	0 ± 0**	-	7 ± 4
1/4 lb	2.5% 1/4 oz	2 lb	EL-107	1 lb	2 ± 0	29 ± 1	0 ± 1	15 ± 2	9 ± 5
1/4 lb	2.5% 1/4 oz	2 lb	EL-107	2 lb	0 ± 0	-	1 ± 1	12 ± 2	0 ± 1
1/4 lb	2.5% 1/4 oz	2 lb	Goal	0.25 lb	0 ± 0	-	0 ± 0	-	10 ± 2
1/4 lb	2.5% 1/4 oz	2 lb	Hoelon	0.75 lb	0 ± 0	-	1 ± 1***	16 ± 0	3 ± 1
* Orchardgrass 5/ft ² ; 32 inches tall		*** Orchardgrass 4/ft ² ; 23 inches tall		** See footnote to Table					

Table 6. Varying rates of Poast in combination with the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D amine on seedhead formation in fescue, bluegrass and smooth brome. Applied April 12, 1986

Weather was cool and dry. Evaluations were on June 1, 1986. IN-126 test area. 3' X 6' plots. Initial height of fescue was 11 inches, smooth brome 11.5 inches and bluegrass 9 inches. Results are averages of three replicates \pm standard deviations.

Embark	Amount*			Fescue Seedheads		Bluegrass Seedheads		Smooth Brome Seedheads		
	X-77	Telar	2,4-D	Poast	Per ft ² Height	Per ft ² Height	Per ft ² Height	Per ft ² Height		
-	-	-	-	-	10 ± 2	42 ± 6	3 ± 1	34 ± 2	10 ± 2	36 ± 1
1/4 lb	2.5%	1/4 oz	2 lb	-	0 ± 0	-	1 ± 1	18 ± 0	6 ± 2	32 ± 5
1/4 lb	2.5%	1/4 oz	2 lb	1/4 lb	0 ± 0	-	2 ± 2	24 ± 0	5 ± 3	34 ± 3
1/4 lb	2.5%	1/4 oz	2 lb	1/2 lb	0 ± 0	-	1 ± 2	12 ± 2	4 ± 4	27 ± 3
1/4 lb	2.5%	1/4 oz	2 lb	3/4 lb	0 ± 0	-	0 ± 1	20 ± 5	3 ± 2	31 ± 4
1/4 lb	2.5%	1/4 oz	2 lb	1 lb	0 ± 0	-	0 ± 1	20 ± 5	0 ± 0	-

* Embark = 1b/A as mefluidide, X-77 = % of total volume of spray mixture; Telar = oz/A of active material; 2,4-D = 1b/A of acid equivalent; Poast = 1b/A of active material.

Table 7. As in Table 6 above except that applications were on April 19, 1986. Weather was cool and dry. Fescue height was 12.5 in, smooth brome 12.5 inches and bluegrass 9.5 inches.

Embark	Amount *			Fescue Seedheads		Bluegrass Seedheads		Smooth Brome Seedheads		
	X-77	Telar	2,4-D	Poast	Per ft ² Height	Per ft ² Height	Per ft ² Height	Per ft ² Height		
-	-	-	-	-	11 \pm 1	42 \pm 5	2 \pm 2	24 \pm 2	8 \pm 3	37 \pm 1
1/4 lb	2.5%	1/4 oz	2 lb	-	0 \pm 0	-	1 \pm 1	11 \pm 2	6 \pm 2	29 \pm 3
1/4 lb	2.5%	1/4 oz	2 lb	1/4 lb	1 \pm 2	37 \pm 3	1 \pm 0	11 \pm 2	4 \pm 4	36 \pm 3
1/4 lb	2.5%	1/4 oz	2 lb	1/2 lb	0 \pm 1	27 \pm 3	1 \pm 3	15 \pm 5	3 \pm 3	30 \pm 2
1/4 lb	2.5%	1/4 oz	2 lb	3/4 lb	0 \pm 0	-	3 \pm 3	18 \pm 4	3 \pm 3	30 \pm 2
1/4 lb	2.5%	1/4 oz	2 lb	1 lb**	0 \pm 0	-	0 \pm 0	-	0 \pm 0	- (Dying)

*See footnote to Table 6. **Grass appeared to be dying.

Table 8. Effect of Dinitrophenol and Hoe1on in the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D on seedhead formation in fescue, bluegrass and smooth brome. Applied April 19, 1986. Weather warm and dry. Evaluations were on June 1, 1986. IN-126 test area. 3' X 6' plots. Initial height of fescue and smooth brome 12.5 inches, bluegrass 9.5 inches. Results are averages from three replications + standard deviations.

Embark	X-77	Telar	2,4-D	Hoe1on	Dinitrophenol	Amount*		Fescue Seedheads		Bluegrass Seedheads		Smooth Brome Seedheads	
								Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-			11 + 2	42 + 3	2 + 2	24 + 2	6 + 2	37 + 1
1/4 lb	2.5%	1/4 oz	2 lb	1.5 lb	-			1 + 2	21 + 3	1 + 1	18 + 1	3 + 3	26 + 4
1/4 lb	2.5%	1/4 oz	2 lb	-	0.5 lb			3 + 1	34 + 2	2 + 0	21 + 3	5 + 4	35 + 2
1/4 lb	2.5%	1/4 oz	2 lb	-	1.0 lb			1 + 1	21 + 2	2 + 1	19 + 4	1 + 1	28 + 2

Table 9. Effect of Premerge and Roundup in the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D amine on seedhead formation in fescue, bluegrass and smooth brome. Applied April 23, 1986. Weather warm and dry. Evaluations were on June 1, 1986. IN-126 test area. 3' X 6' plots. Initial height of fescue and smooth brome 12.5 inches, bluegrass 9.5 inches. Results are averages from three replications + standard deviations.

Embark	X-77	Telar	2,4-D	Premeerge	Roundup	Amount*		Fescue Seedheads		Bluegrass Seedheads		Smooth Brome Seedheads	
								Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-			10 + 3	39 + 3	4 + 2	27 + 2	2 + 0	32 + 1
1/4 lb	0.25%	1/4 oz	2 lb	-	-			0 + 0	-	2 + 2	14 + 0	0 + 0	-
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	-			2 + 2	13 + 1	1 + 1	12 + 3	2 + 0	24 + 3
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	-			1 + 1	13 + 2	1 + 1	14 + 1	-	-
1/4 lb	0.25%	1/4 oz	2 lb	1 lb	-			0 + 1	11 + 2	3 + 2	17 + 1	-	-
1/4 lb	0.25%	1/4 oz	2 lb	-	1 lb**			0 + 0	-	1 + 1	14 + 2	-	-

* Embark = 1b/A mefluidide; X-77 = % by volume of total spray mixture; Telar = oz/acre active material; 2,4-D amine = 1b/A of acid equivalent; all other materials = 1b/A active material; ** Grass dead or dying; ***Orchardgrass 4 seedheads/ft², 34 inches tall. Visually plots with premerge appeared healthier and more even than the standard mixture alone. Short fescue seed heads were formed.

Table 10. Premerge in combination with Embark and Telar plus 2,4-D and Surfactant on seedhead formation in smooth brome. Applied April 29, 1986. Evaluations were on May 28, 1986. IN-126 test area. 3' X 6' plots. Initial height of smooth brome was 17 inches (fescue, 13 in; bluegrass 9-10 in).

<u>Embark</u>	<u>X-77</u>	<u>Amount*</u>		<u>Premerge</u>	<u>Roundup</u>	<u>Smooth Brome Seedheads</u>	
		<u>Telar</u>	<u>2,4-D</u>			<u>Per ft²</u>	<u>Height</u>
-	-	-	-	-	-	8 ± 0	30 ± 1
1/4 lb	0.25%	1/4 oz	2 lb	-	-	8 ± 0	31 ± 2
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	-	6 ± 2	27 ± 3
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	-	6 ± 2	28 ± 6
1/4 lb	0.25%	1/4 oz	2 lb	1 lb	-	9 ± 1	30 ± 2
1/4 lb	0.25%	1/4 oz	2 lb	-	1 lb	5 ± 1	26 ± 8

* Embark = 1b/A mefluidide; X-77 = % by volume of total spray mixture; Telar = oz/A active material; 2,4-D amine = 1b/A of acid equivalent; all other materials = 1b/A active material. Grass sprayed with Roundup showed delayed seedhead emergence.

Table 11 . Varying rates of Poast with or without crop oil in combination with the standard mixture of Embark plus telar, X-77 surfactant and 2,4-D amine on seedhead formation in smooth brome. Applied May 1, 1986. Evaluations were on May 28, 1986. IN-126 test area. 3' X 6' plots. Initial height of smooth brome was 17 inches (fescue 17 in; bluegrass 10 in; 13 inch seedheads).

Amount*						Smooth brome seedheads	
Embark	X-77	Telar	2,4-D	Poast	Crop Oil	Per ft ²	Height
-	-	-	-	-	-	11 + 1	36 + 0
1/4 lb	0.25%	1/4 oz	2 lb	-	-	10 + 2	34 + 2
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	-	10 + 2	33 + 2
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	-	7 + 3	28 + 8
1/4 lb	0.25%	1/4 oz	2 lb	3/4 lb	-	10 + 2	32 + 4
1/4 lb	0.25%	1/4 oz	2 lb	1 lb	-	10 + 2	16 + 4
1/4 lb	0.25%	1/4 oz	2 lb	1/8 lb	1/2 qt	10 + 2	30 + 6
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	1 qt	8 + 2	27 + 3
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	2 qt	4 + 2	20 + 2
1/4 lb	0.25%	1/4 oz	2 lb	3/4 lb	3 qt	5 + 2	23 + 6
1/4 lb	0.25%	1/4 oz	2 lb	1 lb	4 qt	4 + 4	15 + 5
-	-	-	-	1/4 lb	1 qt	3 + 1	23 + 3 **

* Embark = lb/A as mefluidide, X-77 = % of total volume of spray mixture; Telar = oz/A of active material; 2,4-D and Poast = lb/A of active material, crop oil = quarts/acre.

** Grass very yellow. Antagonism between Embark and Post to reduce discoloration.

Table 12 . Varying rates of Roundup in combination with the standard mixture of Embark plus Telar, X-77 surfactant and 2,4-D Amine on seedhead formation and blade height of smooth brome and bluegrass. Applied May 2, 1968. Evaluations on May 28, 1978. IN-126 test area. Brome and fescue 15 inches and bluegrass 10 inches at time of application.

Amount*					Smooth Brome		Bluegrass	
Embark	X-77	Telar	2,4-D	Roundup	Seeheads/ft ²	Blade Height	Per ft ²	Seedheads Height
-	-	-	-	-	10 + 2	27 + 2	18 + 2	28 + 3
1/4 lb	0.25%	1/4 oz	2 lb	-	11 + 1	18 + 1	17 + 3	21 + 2
1/4 lb	0.25%	1/4 oz	2 lb	1/16 lb	12 + 2	21 + 2	15 + 3	28 + 3
1/4 lb	0.25%	1/4 oz	2 lb	1/8 lb	9 + 2	20 + 3	16 + 2	22 + 1
1/4 lb	0.25%	1/4 oz	2 lb	1/4 lb	11 + 3	22 + 1	15 + 2	27 + 7
1/4 lb	0.25%	1/4 oz	2 lb	1/2 lb	9 + 2	17 + 2	15 + 3	21 + 4
-	-	-	-	1/16 lb	12 + 3	26 + 3	12 + 2	24 + 1
-	-	-	-	1/8 lb	10 + 2	25 + 1	12 + 2	22 + 3
-	-	-	-	3/16 lb	10 + 2	22 + 2	12 + 3	27 + 5
-	-	-	-	1/4 lb	11 + 1	22 + 2	12 + 3	27 + 4

* Embark = lb/A as mefluidide, X-77 = % of total volume of spray mixture. Telar = oz/A of active material, 2,4-D and Roundup = lb/A of active material.

No toxicity or discoloration noted even at the 1/2/A rate of Roundup in the combination

Table 13. Effect of Embark plus Telar in combination with Goal, Balan and Poast on seedhead formation in smooth brome. IN-126 test area. Treatments applied on May 13, 1986. Evaluations on May 28, 1986.

Embark	Amount per acre*					2,4-D Amine	Smooth Brome Seedheads	
	X-77	Telar	Goal	Balan	Poast		Per ft ²	Height**
-	-	-	-	-	-	2 lb	12 ± 0	29 ± 1
1/4 lb	0.25%	1/4 oz	-	-	-	2 lb	12 ± 0	29 ± 1
1/4 lb	0.25%	1/4 oz	1/8 lb	-	-	2 lb	12 ± 0	31 ± 1
1/4 lb	0.25%	1/4 oz	1/4 lb	-	-	2 lb	12 ± 0	30 ± 2
1/4 lb	0.25%	1/4 oz	1/2 lb	-	-	2 lb	12 ± 0	25 ± 1
1/4 lb	0.25%	1/4 oz	3/4 lb	-	-	2 lb	9 ± 3	28 ± 1
1/4 lb	0.25%	1/4 oz	-	4 lb	-	2 lb	12 ± 0	30 ± 2
1/4 lb	0.25%	1/4 oz	-	8 lb	-	2 lb	11 ± 1	25 ± 2
1/4 lb	0.25%	1/4 oz	-	12 lb	-	2 lb	0 ± 0	-
1/4 lb	0.25%	1/4 oz	-	16 lb	-	2 lb	0 ± 0	-
1/4 lb	0.25%	1/4 oz	-	-	1/4 lb	2 lb	12 ± 0	22 ± 1
1/4 lb	0.25%	1/4 oz	-	-	1/2 lb	2 lb	7 ± 2	22 ± 3
1/4 lb	0.25%	1/4 oz	-	-	1 lb	2 lb	1 ± 1	(24) -
1/4 lb	0.25%	1/4 oz	-	-	2 lb	2 lb	0 ± 0	-

* Amounts are in pounds per acre of active ingredient except for X-77 which is given as the percentage by volume of the total spray mixture.

** Seedhead heights in inches.

Table 14. Effect of Poast alone and in combination with crop oil on growth and toxicity to fescue when added to the combination Embark plus 2,4-D amine. Treatments were applied to mowed fescue on September 26, 1986. Evaluations were on November 11, 1986. Triplicate 3' X 6' plots under roadside conditions (IN 126, Tippecanoe, County Indiana). Initial height of fescue, approximately 10 inches.

Amount per acre					Fescue	
Embark	Telar	2,4-D	Poast	Crop oil	Extended blade height (in)	Color Index ^a
-	-	-	-	-	15 ± 2	10 ± 10
1/4 lb	1/4 oz	2 lb	-	-	14 ± 2	9 ± 1
1/4 lb	-	2 lb	1/2 lb	-	11 ± 3	4 ± 1
1/4 lb	-	2 lb	1 lb	-	11 ± 3	4 ± 2
1/4 lb	-	2 lb	1/2 lb	1 qt	10 ± 1	4 ± 0
1/4 lb	-	2 lb	1 lb	1 qt	13 ± 2	5 ± 1
1/4 lb	-	2 lb	-	1 qt	14 ± 1	9 ± 1
1/4 lb	-	2 lb	-	2 qt	15 ± 1	10 ± 1

^a Color Index: 10 = completely green
0 = completely yellow or brown

Table 15. Effect of ACP 1900 in combination with Embark and Telar on growth and seedhead formation in bluegrass and fescue. Sprayed April 17. Initial height of fescue 12 in; bluegrass 9 in. Evaluation on May 22, 1986.

Amount per acre					Bluegrass Seedheads		Fescue Seedheads	
Embark	X-77*	Telar	2,4-D	ACP 1900	per ft ²	Height	per ft ²	Height
-	-	-	-	-	3 ± 1	12 ± 1	9 ± 2	24 ± 1
1/4 lb	0.25%	1/4 oz	2 lb	-	0 ± 0	-	2 ± 2	11 ± 3
1/4 lb	0.25%	-	2 lb	1/8 oz	2 ± 1	12 ± 1	5 ± 2	24 ± 1
-	0.25%	-	2 lb	1/4 oz	2 ± 1	12 ± 1	7 ± 2	23 ± 2
-	0.25%	1/4 oz	2 lb	1/8 oz	2 ± 1	12 ± 2	5 ± 2	24 ± 1
1/2 lb	0.25%	-	2 lb	-	0 ± 0	-	2 ± 2	11 ± 3

* As percent of total spray mixture

Smooth brome was not controlled by any of the treatments,

Table 16

Evaluation of I-70 on August 13, 1986. Don Bickle, Andrew Brightman and D. James Morre. Applied with Swinglok equipment on April 22, 1986. Application rate 25 gpa. Each treatment plots was compared with a corresponding check in the same general area. All areas evaluated were in the west-bound lane between the pavement and ditch from mile marker 25 to SR 59.

Treatment	Fescue			Bluegrass		
	SH/ft ²	SH Ht	Bld Ht	SH/ft ²	SH Ht	Bld Ht
Check	15 ± 4	36 ± 2	16 ± 1	3 ± 1	17 ± 1	11 ± 1
Schedule B*	12 ± 2	20 ± 2	16 ± 3	3 ± 1	11 ± 1	12 ± 1
	9 ± 1	24 ± 2	14 ± 1	1 ± 1	11 ± 1	10 ± 1
	4 ± 2	23 ± 0				
Check	11 ± 1	39 ± 1	17 ± 1	2 ± 1	18 ± 6	11 ± 1
Schedule C*	9 ± 5	15 ± 4	11 ± 1	1 ± 3	9 ± 1	10 ± 2
Check	13 ± 1	36 ± 4	14 ± 2	10 ± 2	16 ± 1	11 ± 1
Schedule C*	12 ± 0	20 ± 2	13 ± 1	5 ± 3	8 ± 2	10 ± 0
Check	20 ± 2	35 ± 5	16 ± 1	4 ± 2	17 ± 1	11 ± 1
Limit + Telar**	20 ± 2	27 ± 2	17 ± 1	2 ± 1	16 ± 2	12 ± 1

Weed control was excellent, estimated to be greater than 87% based on actual weed counts compared to unsprayed areas adjacent to the ditch. 2,4-D + Telar susceptible species such as plantain, dandelion, wild carrot, parsnip, curled dock and clovers were virtually absent.

* Schedule B = 1/4 lb/A Embark + 1/4 oz/A Telar + 0.25% X-77 Surfactant + 2 lb/A 2,4-D Amine

Schedule C = 1/8 lb/A Embark + 1/8 oz/A Telar + 0.125% X-77 Surfactant + 1 lb/A 2,4-D Amine

**Limit + Telar = 1/4 oz/A of Telar + 1 gallon of limit over 20 ft X 2.5 miles = 264,000 ft² = 6 acres. Limit = Mon 6421 = 4 lb/A = 0.7 lb/A.

Conclusions: Schedule C (1/8 lb Embark + 1/8 oz Telar) was equivalent to schedule B (1/4 lb Embark + 1/4 oz Telar). Limit + Telar was largely without effect.

Schedule B and C control of fescue was largely a reduction in seedhead height and vigor. Except for late flowering prairie species such as fall panicum, yellow foxtail and purpletop, mowing would not have been required. Treated areas following mowing showed very little evidence of accumulations of mowed grass whereas the untreated areas and the Limit + Telar plots showed large accumulations of mowed grass (at least a 10-fold difference in amount).

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Table 17

Secondary Road Test: 1986. List of Treatments. Area sprayed was 136 N from Lizton to New Ross. Applied May 13, 1986. Evaluation was on July 25, 1986. Treatments were applied without Telar and without surfactant. Telar (1/4 oz/A) + 2,4-D, (1b/ were applied 1-2 days later. Plots were 2 acres in area and about 1 mile long. Fescue seedheads were showing when the area was sprayed. Rate of application: 25 gr

Treatment Number	Amount per Acre											
	Embark	2,4-D	Poast	Crop Round			Embark	2,4-D	Poast	Crop Round		
				Oil	Up	Balan				Oil	Up	Balan
0	-	-	-	-	-	-	-	-	-	-	-	-
1	1 pt	1/2 gal	1 qt	-	-	-	1/4 1b	2 1b	1/2 1b	-	-	-
2	1 pt	1/2 gal	2 qt	1 qt	-	-	1/4 1b	2 1b	1 1b	1 qt	-	-
3		1/2 gal	1 qt	1 qt	-	-	1/4 1b	2 1b	1/2 1b	1 qt	-	-
4	-	-	-	-	6 oz	-	-	-	-	-	6 oz	-
5		1/2 gal	-	-	-	1 1/2 gal	1/4 1b	2 1b	-	-	-	3 1

Table 18

Secondary Road Test: 1986. Effect of Seedhead Formation in Roadside Turf Grasses

Treatment Number	Fescue			Bluegrass		Smooth Brome		Orchardgrass		Timothy	
	SH/Ft ²	SH Ht	Bld Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht
0 (Check)	15 ⁺³	39 ⁺²	27 ⁺³	6 ⁺²	30 ⁺³	14 ⁺²	50 ⁺³	14 ⁺³	44 ⁺⁴	12 ⁺⁴	41 ⁺¹
1	10 ⁺⁵	24 ⁺⁶	18 ⁺¹	14 ⁺²	18 ⁺²	7 ⁺²	29 ⁺⁴	10 ⁺⁹	31 ⁺⁹	-	-
2	0 ⁺⁰	-	21 ⁺¹	3 ⁺¹	16 ⁺²	10 ⁺⁴	26 ⁺⁶	4 ⁺³	16 ⁺¹	1 ⁺⁰	29 ⁺¹
3	0 ⁺⁰	-	19 ⁺¹	3 ⁺¹	14 ⁺⁰	2 ⁺²	24 ⁺⁶	2 ⁺⁴	15 ⁺³	-	-
4	12 ⁺⁴	29 ⁺⁶	25 ⁺²	7 ⁺¹	31 ⁺⁶	11 ⁺³	34 ⁺⁶	8 ⁺⁴	23 ⁺²	-	-
5	18 ⁺²	24 ⁺¹	25 ⁺¹	5 ⁺⁵	16 ⁺¹	6 ⁺²	34 ⁺²	3 ⁺²	34 ⁺²	-	-

Secondary Road Test: 1986. Treatment Notes

- 0 (Check) Essentially no weeds except for plantain and a few carrot skips. Had been sprayed with Telar/2,4-D mixture.
- 1 Good evidence of smooth brome control. No injury obvious.
- 2 Good control. No injury.
- 3 Burning of fescue. Killed? Foxtail growth delayed.
- 4 No evidence of injury.
- 5 No yellowing at any time. About 80% control of foxtail and annual grasses. Sprayed too late and without Telar. Fescue seedheads showing when sprayed

Secondary Road Test: 1986. Control of Foxtail and Annual Grasses. Sampled adjacent to pavement where stands were heaviest.

Treatment Number	Yellow Foxtail		Giant Foxtail		Barnyard Grass*		Notes
	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	SH/Ft ²	SH Ht	
0 (Check)	4 ± 3	27 ± 2	4 ± 1	22 ± 1	3 ± 2	24 ± 4	Foxtail just beginning to form seedheads.
1	8 ± 1	16 ± 4	7 ± 1	25 ± 6	3 ± 2	24 ± 4	No control in number. Growth delayed.
2	6 ± 6	15 ± 3	1 ± 1	18 ± 1	2 ± 1	22 ± 8	Growth delayed.
3	8 ± 4	17 ± 10	4 ± 2	22 ± 7	2 ± 1	21 ± 9	Growth delayed.
4	8 ± 1	20 ± 2	4 ± 2	31 ± 6	4 ± 1	31 ± 7	No effect. Like check.
5	1 ± 1	10 ± 3	1 ± 1	11 ± 2	1 ± 1	12 ± 2	About 80% control.

*Results with Crabgrass were similar.

Table 20

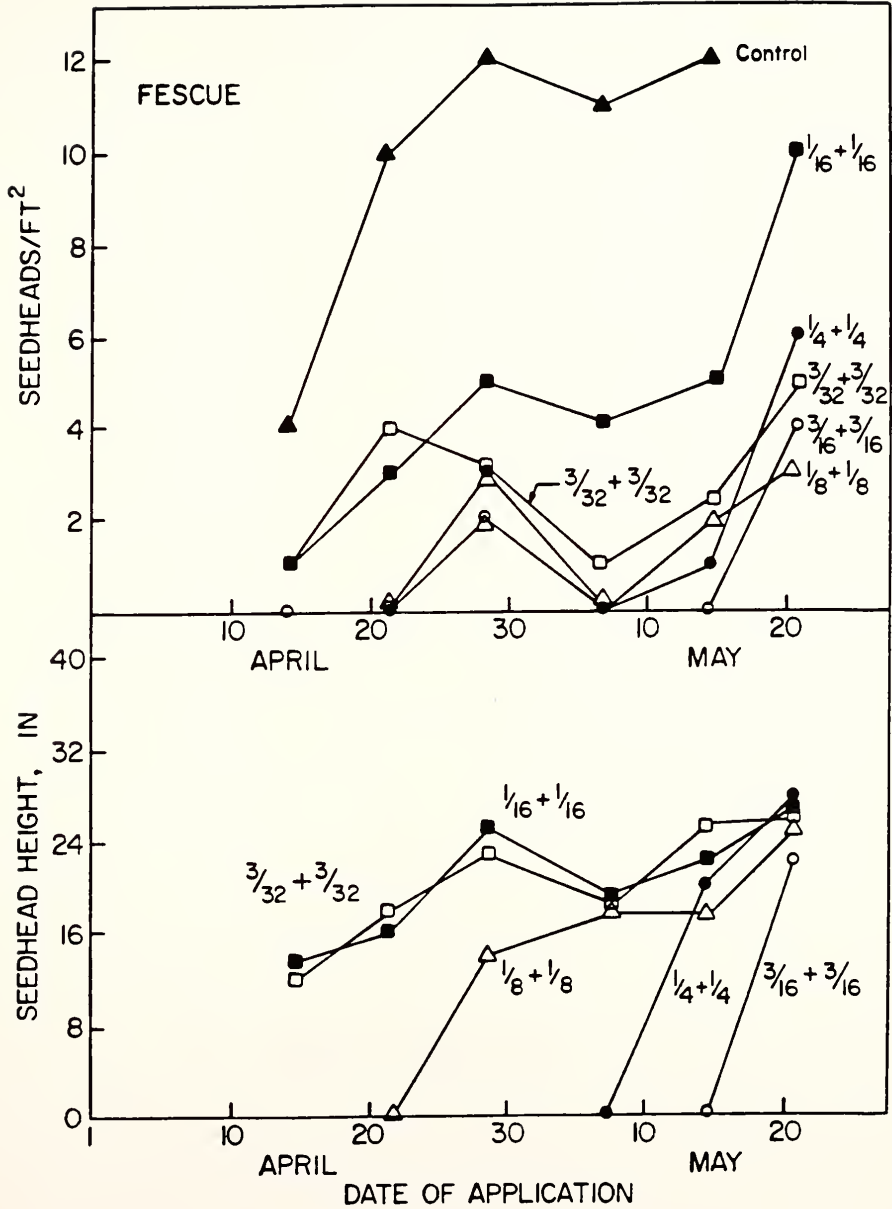
Results of September 15 meeting with Dr. Domingo Riego, Monsanto Agricultural Products. Clyde Mason, IDOH and Dan Zay (IDOH) to rate plant growth regulator plots applied to mixed tall fescue-bluegrass stands in the vicinity of exit 49A, I-465 N east of Indianapolis. Applications were by Monsanto together with Clyde Mason. Most plots contained insufficient bluegrass to permit ready evaluation of effects on that species.

Treatment	nd rate per acre	Fescue			Bluegrass		
		SH/ft ²	SH Ht	Bld Ht	SH/ft ²	SH Ht	Bld
Control		14	46	24			
Applications on April 10:							
Mon 8000	4 oz (ave of two formulations)	15	46	26			
	6 oz " " "	11	42	25			
	8 oz " " "	4	41	21			
Oust	1/4 oz	4	19	16			
	1/2 oz	Toxic					
Escort	1/2 oz	16	46	23	\$15/A; cost \$30/o		
Telar	1/4 oz	16	46	24			
	1/2 oz	14	36	23			
Oust	1/8 oz	6	28	20			
Mon 8000	6 oz + Oust 1/8 oz + 2,4-D 1 qt	1	24	19	Much early toxicity		
Mon 8000	8 oz + Oust 1/4 oz	1	24	19	due to Oust		
Mon 8000	8 oz + Oust 1/4 oz	0	-	16	12	14	14
Mon 8000	4 oz + Telar 1/4 oz	6	33	22	No injury		
Mon 8000	8 oz + Oust 1/4 oz + 2,4-D 1 qt	0	-	18	Late seedheads		
Mon 8000	2 oz + Oust 1/8 oz	0	-	17	Timothy escaped		
Mon 8000	8 oz + Oust 1/8 oz	2	33	19			
Mon 8000	8 oz + Oust 1/4 oz	0	-	16			
Mon 8000	8 oz + Oust 1/8 oz + 2,4-D 1 qt	3	26	17			
Applications on April 20							
Limit	1 1/2 qt + 1/4 oz Telar	12	32	23	\$40/A root uptake		
Limit	1 1/2 qt + 1/4 oz Telar + 1 qt 2,4-D	12	33	23	apply early March		
Limit	1 1/2 qt + 1/4 oz Escort	4	32	21	looks good; cost		
Limit	1 1/2 qt + 1/4 oz Escort + 1 qt 2,4-D	10	46	23**	must apply later		
Mon 8000	6 oz + Telar 1/4 oz	12	28	18	appln. too late: wind		
Mon 8000	6 oz + Telar 1/4 oz + 2,4-D 1 qt	2	31	18	3	14	13
Check (bluegrass only)					20	24	20
Mon 8000	6 oz + Escort 1/4 oz	4	25	17	too expensive		
Mon 8000	6 oz + Escort 1/4 oz + 2,4-D 1 qt	12	33	20**	**Antagonism w 2,		
Mon 8000	6 oz + Telar 1/4 oz	1	21	20	looks good		
Mon 8000	6 oz + Oust 1/8 oz	0	-	19	yellowed earlier		
Mon 8000	6 oz + Telar 1/4 oz (another form.)	2	32	23	\$10-12 per acre		
Mon 8000	6 oz + Telar 1/4 oz + 2,4-D 1 qt	2	28	19	\$12-14 per acre		
Control		14	46	27			

SH/ft² = seedheads/square foot

SH Ht = height of the majority of conspicuous seedheads formed in inches

Bld Ht = maximum extended blade length in inches



Appendix Figure 1. Embark (lb/A) + Telar (oz/A) combinations, 1986 rate and date study in combination with 2,4-D (2 lb/A) and X-77 surfactant (0.25% of the total spray mixture). Numbers refer to rates of Embark and Telar, respectively.

A P P E N D I X I I

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SUMMARY OF MAJOR FINDINGS

1987

SUMMARY OF MAJOR FINDINGS

In 1987 emphasis was on a detailed evaluation of a new primary retardant material, Manage and on the use of Verdict as an additive. Various mixtures to control seedhead formation in smooth brome and with pre-emergence activity toward annual grasses and weeds were evaluated with a view toward their implementation for use on secondary roads. Some additional discussion of findings and summations are provided with the tables and figures that follow as well as procedural details not included in the main body of the report

1. More than 750 individual research plots were established and evaluated in 1987. The tables that follow record the results of those tests.
2. On 21 different dates, Manage alone or in combination with Telar and other materials was applied at different rates and ratios together with 2,4-D amine at 2 lb/A and X-77 surfactant at 0.25% by volume of the total spray mixture (Tables 1, 2, 5, 6, 7, 9, 10, 11, 12, 15, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36 and 37). Manage was most effective in 1987 during a very narrow window in the first week of May. Applications before May 1 and after May 5 were less effective. These findings are summarized in Table 22 and presented graphically in Figure 8 of the main body of the report.
3. Addition of Telar to the combination with Manage increased effectiveness somewhat but was most effective at low rates of Manage (Tables 1, 2, 5, 6, 24, 25, 27, 29, 31 and 32). At a near optimum rate of Manage of 4 oz/A, fescue seedhead control was on the average about 50%. Addition of 1/4 oz/A Telar to the mixture increased seedhead control to 65% comparing 8 different dates of application.
4. For control of seedheads in smooth brome, testing concentrated heavily on mixtures of Embark + Garlon with varying concentrations of Verdict + 2,4-D

(e.g. Table 3, 15 and 18). A combination of Garlon with Embark and surfactant does appear to provide the desired control of seedheads in smooth brome.

5. Overall, Manage appears to be superior to Embark as a primary agent for control of seedheads in smooth brome (Tables 7, 11 and 13).
6. Addition of Garlon to mixtures containing Manage as the primary retardant is also effective (Tables 5, 6, 7 and 12) but seedhead control in smooth brome with the Manage combinations has been obtained only at very high rates of Manage of 6 oz/A or more, rates near the levels toxic to bluegrass.
7. Addition of Verdict to the combination of Garlon and Manage did not result in a clear improvement (Tables 3, 4 and 28).
8. In one experiment applied on April 27, 1987, a mixture of 4 oz/A of Manage + 1/2 lb/A Garlon + 1/32 lb/A of Verdict in the presence of 0.25% by volume of the total spray mixture of X-77 surfactant gave 100% control of seedheads in smooth brome (Table 12). This treatment should be investigated further.
9. A number of treatments selected from 1984, 1985 and 1986 field trials were compared for seedhead suppression of smooth brome both in small plots (Tables 7, 8, 14, 21, 23, 26 and 33) and in implementation studies (Table 38). The activity of Garlon in combination with Embark or Manage was confirmed.
10. Poast, added to the standard mixture of Schedule B at a rate of 0.3 lb/A or upwards gave good seedhead suppression of smooth brome as well as orchard-grass and other Embark-resistant species (Tables 7, 8, 14, 23, 33 and 38).
11. Effectiveness of the Poast was augmented by inclusion of 1 quart/A of crop oil (Tables 8, 23, 33, 38).
12. Toxicity of the Poast was more notable in 1987 than in 1986 (e.g, Tables 8 and 34). Reductions in stand of both bluegrass and fescue were seen in these experiments but not in others (Table 33).

13. Balan added to schedule B was effective as a pre-emergence grass agent and appeared to enhance Embark activity against smooth brome in some experiments (Table 21; See also Tables 4 and 13 of Appendix I summarizing 1986 results) but not in others (Table 26).
14. For seedhead control in fescue, Embark was consistently more effective than Manage (Table 11 and 16).
15. Side-by-side comparisons of Manage (4 oz/A) + Telar (1/4 oz/A) and of Embark (1/4 lb/A) + Telar (1/4 oz/A) according to Schedule B in combination with 2,4-D amine and surfactant were carried out in 9 trials (Tables 7, 11, 16, 19, 20, 25, 27, 29 and 32). Overall, the Embark + Telar + 2,4-D + Surfactant gave 90% control of fescue seedheads in these trials as in past years. In contrast, the combination of Manage + Telar + 2,4-D + Surfactant gave only 70% control of fescue seedheads which was very near the overall average for the year of 65% control. Only with the two mid-season applications were the treatments equivalent. Both early and late, the Embark combination was decidedly superior in inhibition of fescue seedheads.
16. In the combination of Manage + Telar, the Telar was most effective at low rates of Manage (Table 13). The effectiveness of Telar was maximal between 1/16 and 3/32 oz/A. Increasing the amount of Telar to 3/8 oz/A had no additional effect.
17. With schedule C (1/8 lb/A of Embark as the primary retardant), varying the rate of telar gave a graded response through 1/4 oz/A beginning with 1/32 oz/A showing an effect. Increasing the amount of Telar in this combination above 1/8 oz/A or decreasing it below 3/32 oz/A appears of doubtful value.
18. ACP 1900 was evaluated for the fourth consecutive year in combination with Embark and Telar both as a primary retardant and as an additive. While

the material was quite active, it appeared to offer no advantage either over Embark as a primary retardant in combination with Telar or over Telar as an additive in combination with Embark (Tables 16 and 37).

19. Mon 4625 and Mon 4629 also were evaluated as primary retardants (Table 17 and 35) and seemed to offer no particular advantage over Manage.
20. Manage at rates of 3, 4 or 6 oz/A gave essentially equivalent results with about 50% control of fescue seedheads and a 40% reduction in seedhead elongation (Tables 22, 26, 28 and 36). Rates of Manage at 6 oz/A or above could not be used practically in the roadside program due to potential toxicity to bluegrass.
21. Rates of manage of 2 oz/A or less were largely ineffective (Tables 2 and 22).
22. The effectiveness of Telar added to Manage was maximal between 1/16 and 3/32 oz/A of Telar (Table 24). Increasing the amount of Telar to 3/8 oz/A had no additional effect.
23. Oust, a chemical relative of Telar, was more effective pound for pound in combination with Embark than was Telar (Table 29).
24. Addition of Oust to the combination with Manage also increased effectiveness (Tables 29, 30 and 31).
25. With Oust, 1/8 oz/A appeared to give optimal results (Tables 30 and 31).
26. Implementation trials comparing Manage 4 oz/A + Telar 1/4 oz/A in combination with 2 lb/A 2,4-D amine gave results equivalent to Embark + Telar Schedule C (Table 38).
27. Fall tests on the flush of regrowth in bluegrass have been found to serve as accurate predictors of spring activity especially in terms of antagonism and synergism.
28. As anticipated from the spring applications, Garlon 4 was antagonistic with the Embark-Verdict-2,4-D mixture when 2,4-D was included (Table 40).
29. If Verdict was replaced by Telar in the mixture, the antagonism with Garlon 4

was reduced or absent (Table 41). These results summarize findings from two application dates.

30. That the antagonism of Garlon-4 in the Embark-Verdict-2,4-D mixture is due primarily to the presence of the 2,4-D is suggested strongly by the results of Table 42. The addition of verdict to the Embark was additive and a second positive (synergistic?) interaction occurred with the addition of 2,4-D. Only when both 2,4-D and Garlon were present was the interaction negative (antagonistic).
31. With Verdict as the additive, Garlon antagonism was seen only with 1 and 2 lb/A 2,4-D amine but not in the absence of 2,4-D or in the presence of the lowest rate, 1/2 lb/A, of 2,4-D (Table 43).
32. The antagonism of Garlon in the mixture was strongly rate dependent for Garlon (Tables 44 and 45). The higher the rate of Garlon the greater the antagonism. This may explain field results where seedhead suppression in smooth brome was often better at 1/2 lb/A of Garlon in the mixture than at the higher rate of 1 lb/A (Tables 3, 5, 6 and 19). This type of observation necessitates the need for continued careful small plot evaluations of the interactions among all components in the mixture, including rate and date dependency, in order to optimize final use conditions.
33. An even greater 2,4-D dependency is seen with Fluroxypyr a chemical relative of Garlon (Table 46).
34. The solution to the 2,4-D/Garlon antagonism is to reduce or eliminate the 2,4-D amine from the combination and to replace the Verdict with Telar. Both Telar and Garlon have herbicide activity and the 2,4-D may no longer be needed in the mixture in any event. These two possibilities should be tested further in the spring of 1988.

Table 1. Early application of Manage with or without Telar ineffective for control of seedhead formation. Treatment applied April 10, 1987. Evaluation on May 29, 1987. IN 126 test area. 3' X 6' plots. Initial heights fescue, 11 inches; bluegrass, 7 inches; smooth brome 10 inches.

				Seedheads							
Amount per acre*				Fescue		Bluegrass		Smooth Brome		Orchardgrass	
<u>Manage</u>	<u>X-77</u>	<u>Telar</u>	<u>2,4-D</u>	<u>Per .ft²</u>	<u>Ht</u>	<u>Per ft²</u>	<u>Ht</u>	<u>Per ft²</u>	<u>Ht</u>	<u>Per ft²</u>	<u>Ht</u>
-	-	-	-	14 _{±2}	42 _{±4}	4 _{±1}	36 _{±1}	12 _{±6}	40 _{±7}	2	37
6 oz	0.25%	-	2 lb	10 _{±4}	38 _{±2}	2 _{±1}	31 _{±2}	12 _{±5}	41 _{±6}	5 _{±1}	39 _{±1}
6 oz	0.25%	1/4 oz	2 lb	11 _{±2}	41 _{±2}	1 _{±1}	33 _{±4}	15 _{±1}	41 _{±5}	4	40

* Amounts are in pounds or ounces per acre except for X-77 surfactant which is as the percent by volume of the total spray mixture. 2,4-D is 2,4-D amine.

Grass heights are in inches _± standard deviations from three replications.

Table 2. Varying rates of Manage alone and in combination with Telar and 2,4-D on seedhead formation in fescue, bluegrass and smooth brome. Application on April 13. Evaluation on May 13.

Amount per acre				Seedheads					
Manage	X-77	Glean	2,4-D	Fescue		Bluegrass		Smooth Brome	
				Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	11 ± 2	32 ± 2	6 ± 2	30 ± 2	8	28
2 oz	0.25%	-	-	15 ± 3	30 ± 1	5 ± 3	26 ± 4	6	28
2 oz	0.25%	1/4 oz	-	9 ± 6	34 ± 4	5 ± 5	31 ± 5	6	26
4 oz	0.25%	-	-	1	20	3 ± 3	18 ± 0	4	20
4 oz	0.25%	-	2 lb	8	23	5 ± 1	27 ± 2	3	25
4 oz	0.25%	1/4 oz	-	3	21	4 ± 2	28 ± 2	4	22
4 oz	0.25%	1/4 oz	2 lb	3	23	3 ± 1	24 ± 1	3	28
6 oz	0.25%	-	-	14	26	5 ± 1	26 ± 2	0	27
6 oz	0.25%	1/4 oz	-	8	26	4 ± 2	21 ± 1	0	28

Table 4. Effect of Embark in combination with Garlon, Verdict, Fluoroxypyr and Telar on vegetative growth of bluegrass, fescue and smooth brome. Treatments applied on April 16, 1987. Evaluations on April 25. Initial heights, fescue 12 inches, bluegrass 10 inches and smooth brome 11 inches

Amount per acre						Grass height, inches		
Embark	X-77*	Garlon	Verdict	Fluoroxypyr	Telar 2,4-D	Bluegrass	Fescue	Smooth Bro
-	-	-	-	-	-	11 \pm 1	12 \pm 0	13 \pm 1
1/4 lb	0.25%	-	-	-	1/4 oz 2 lb	9 \pm 1	11 \pm 1	12 \pm 1
1/8 lb	0.25%	-	-	-	1/8 oz 2 lb	8 \pm 1	11 \pm 1	11 \pm 1
1/4 lb	0.25%	1/2 lb	1/32 lb	-	- 2 lb	9 \pm 1	12 \pm 1	11 \pm 1
1/4 lb	0.25%	1 lb	-	-	-	10 \pm 1	12 \pm 0	12 \pm 1
1/4 lb	0.25%	-	-	1/2 lb	-	10 \pm 1	11 \pm 1	12 \pm 0
1/4 lb	0.25%	1/2 lb	1/32 lb	-	-	8 \pm 1	11 \pm 0	10 \pm 1
1/4 lb	0.25%	-	1/32 lb	-	-	9 \pm 1	12 \pm 0	11 \pm 2
6 oz**	0.25%				1/4 oz 2 lb	9 \pm 1	12 \pm 0	11 \pm 1

* % by weight of the total spray mixture (40 gpa)

** Manage in place of Embark

Table 5. Effect of Manage in combination with Garlon, Verdict, Fluroxypyr and Telar on vegetative growth of bluegrass, fescue and smooth brome. Treatment applied April 18, 1987. Evaluations on April 24. Initial heights, fescue 11 inches, bluegrass 8 inches, smooth brome 10 inches.

Manage	Amount per acre						Grass height, inches		
	X-77*	Garlon	Verdict	Fluroxypyr	Telar	2,4-D	Bluegrass	Fescue	Smooth Bro
-	-	-	-	-	-	-	9 ± 1	12 ± 1	15 ± 1
4 oz	0.25%	-	-	-	-	2 lb	8 ± 0	12 ± 0	12 ± 2
4 oz	0.25%	-	-	-	1/4 oz	2 lb	7 ± 1	10 ± 1	10 ± 0
4 oz	0.25%	-	-	-	1/8 oz	2 lb	8 ± 0	11 ± 1	9 ± 2
4 oz	0.25%	1/2 lb	1/32 lb	-	-	2 lb	7 ± 1	11 ± 0	7 ± 2
4 oz	0.25%	1 lb	1/32 lb	-	-	-	9 ± 1	12 ± 1	12 ± 1
4 oz	0.25%	-	-	1/2 lb	-	-	8 ± 2	11 ± 1	12 ± 2
4 oz	0.25%	1/2 lb	1/32 lb	-	-	-	8 ± 1	11 ± 1	9 ± 1
4 oz	0.25%	-	1/32 lb	-	-	-	8 ± 1	11 ± 1	12 ± 1

* % by weight of the total spray mixture (40 gpa)

Table 6. Effect of Manage in combination with Telar, Garlon, Verdict, Fluroxypyr and 2,4-D on seedhead formation in Fescue, Bluegrass, Smooth Brome and Orchardgrass. IN 126 test area. Application on April 18, 1987. Evaluation on May 31, 1987.

Manage	X-77	Telar	Garlon	Verdict	Amount per acre*		Fescue	Bluegrass	Smooth Brome	Orchardgrass
					Flur-oxypr	2,4-D	Per ft ² Height	Per ft ² Height	Per ft ² Height	Per ft ² Height
4 02***0.25%	-	-	-	-	-	-	14±2	44±2	6±0	27±1
8 02 0.5 %	-	-	-	-	-	2 1b	9±4	35±10	0±0	-
4 02 0.25%	1/4 02	-	-	-	-	4 1b	2±2	19±5	0±0	-
8 02 0.5 %	1/2 02	-	-	-	-	2 1b	12±0	29±3	0±1	(16)
12 02 0.75%	3/4 02	-	-	-	-	4 1b	12±0	30±0	1±1	(14)
16 02 1 %	1 02	-	-	-	-	6 1b	2±2	22±4	0±0	-
4 02 0.25%	1/8 02	-	-	-	-	8 1b	2±2	18±5	0±0	-
8 02 0.5 %	1/4 02	-	-	-	-	2 1b	12±2	34±2	1±1	17±2
12 02 0.75%	3/8 02	-	-	-	-	4 1b	6±3	18±5	3±1	17±1
16 02 1 %	1 02	-	-	-	-	6 1b	4±2	18±4	0±0	-
4 02 0.25%	1/2 1b	1/32 1b	-	-	-	8 1b	2±1	18±2	0±0	-
8 02 0.5 %	1 1b	1/16 1b	-	-	-	2 1b	10±2	35±4	1±2	(9)
12 02 0.75%	1 1/2 1b	3/32 1b	-	-	-	4 1b	6±1	22±2	1±1	(19)
16 02 1 %	2 1b	1/8 1b	-	-	-	6 1b	2±2	23±4	0±0	-
4 02 0.25%	1 1b	1/32 1b	-	-	-	8 1b	1±1	19±1	0±0	-
8 02 0.5 %	2 1b	1/16 1b	-	-	-	13±3	37±4	2±3	(19)	TOXIC
12 02 0.75%	3 1b	3/32 1b	-	-	-	4±0	25±1	1±0	15±1	5±0
16 02 1 %	4 1b	1/8 1b	-	-	-	3±3	21±2	0±0	17±1	28±3
4 02 0.25%	-	-	-	-	-	2±2	20±2	0±0	-	0
8 02 0.5 %	-	-	-	-	-	12±2	33±2	2±1	18±2	-
12 02 0.75%	-	-	-	-	-	11±2	28±5	1±1	16±2	TOXIC
16 02 1 %	-	-	-	-	-	3±2	20±3	0±0	-	TOXIC
4 02 0.25%	1/2 1b	1/32 1b	-	-	-	0±0	-	0±0	-	TOXIC
8 02 0.5 %	1 1b	1/16 1b	-	-	-	13±1	35±3	0±0	-	3±2
12 02 0.75%	1 1/2 1b	3/32 1b	-	-	-	6±0	32±2	2±2	23±4	30±2
16 02 1 %	2 1b	1/8 1b	-	-	-	3±3	25±3	0±0	-	25±3
4 02 0.25%	-	-	-	-	-	2±2	19±2	0±0	-	NOT TOXIC
8 02 0.5 %	-	-	-	-	-	13±1	34±2	0±0	-	9±7
12 02 0.75%	-	-	-	-	-	6±2	24±12	1±1	17±1	36±2
16 02 1 %	-	-	-	-	-	3±3	21±4	0±0	-	30±3
	-	-	-	-	-	2±2	20±3	0±0	-	5
	-	-	-	-	-				-	38

* Amounts are in 1b or 02 per acre except for surfactant X-77 which is percent by volume of the total spray mixture
 **Grass heights in inches
 ***Treatment accidentally overdosed

Table 7. Effect of treatments selected from 1964, 1985 and 1986 trials on seedhead suppression of smooth brome. Treatments applied April 20, 1987. Evaluation on May 17, 1987. IN 126 test area. Initial heights: smooth brome: 13 inches; fescue: 11 inches; bluegrass 8 inches.

Amount per acre****							Smooth Bromine						Fescue		Bluegrass	
<u>Embark</u>	<u>Manage</u>	<u>Telar</u>	<u>Verdict</u>	<u>DNP</u>	<u>Gar-</u> <u>Ton</u>	<u>Bal-</u> <u>Poast an</u>	<u>2,4-D</u>	<u>X-77</u>	<u>Seedheads</u> <u>Per ft²</u>	<u>Height</u>	<u>Blade</u> <u>Height</u>	<u>Seedheads</u> <u>Per ft²</u>	<u>Height</u>	<u>Blade</u> <u>Height</u>	<u>Seedheads</u> <u>Per ft²</u>	<u>Height</u>
-	-	-	-	-	-	-	-	-	12+2	33+2	18+2	11+2	38+2	18+2	2+2	33+2
1/4 lb	-	1/4 oz	-	-	-	-	-	-	10+2	32+3	17+1	4+3	18+2	18+1	1+2	11+2
1/2 lb	-	1/2 oz	-	-	-	-	-	-	4 lb 0.5%	33+2	18+2	0+0	-	18+1	1+1	11+0
3/4 lb	-	3/4 oz	-	-	-	-	-	-	6+2	18+0	18+2	0+0	-	17+1	1+1	11+1
1 lb	-	1 oz	-	-	-	-	-	-	6+2	18+3	18+2	0+0	-	16+1	1+1	10+0
-	6 oz	1/4 oz	-	-	-	-	-	-	2+2	23+3	17+2	2+2	17+4*	15+2	1+1	11+2
-	12 oz	1/2 oz	-	-	-	-	-	-	2+1	17+1	13+2	4+2	15+1	15+2	0+0	-
-	18 oz	3/4 oz	-	-	-	-	-	-	0+0	-	13+2	0+0	-	15+2	0+0	-
-	24 oz	1 oz	-	-	-	-	-	-	0+1	(12)	14+1	0+0	-	15+2	0+0	-
1/4 lb	-	1/4 oz	1/32 lb	1/2 lb	-	-	-	1 lb 0.25%	2+2	20+2	17+2**	5+2	18+2	14+1	2+0	21+2
1/2 lb	-	1/2 oz	1/16 lb	1 lb	-	-	-	2 lb 0.5%	2+2	15+3	18+2**	3+1	22+3	13+1	2+1	13+2
3/4 lb	-	3/4 oz	3/32 lb	1 1/2 lb	-	-	-	3 lb 0.75%	1+1	18+3	18+1**	3+2	18+2	12+1	1+1	15+2
1 lb	-	1 oz	1/4 lb	2 lb	-	-	-	4 lb 1%	1+1	18+2	18+2**	2+1	18+2	18+3	1+1	14+4
-	6 oz	1/4 oz	1/32 lb	1/2 lb	-	-	-	1 lb 0.25%	0+0	-	12+1**	9+1	28+2	15+2	1+1	18+0
-	12 oz	1/2 oz	1/16 lb	1 lb	-	-	-	2 lb 0.5%	0+0	-	11+1**	8+1	19+5	11+2	1+1	14+2
-	18 oz	3/4 lb	3/32 lb	1 1/2 lb	-	-	-	3 lb 0.75%	0+0	-	10+1**	1+2	19+4	12+2	1+1	12+1
-	24 oz	1 lb	1/4 lb	2 lb	-	-	-	4 lb 1%	0+0	-	12+2**	4+3	15+1	11+1	2+1	13+2
1/4 lb	-	1/4 oz	-	-	1/2 lb	-	-	2 lb 0.25%	0+0	-	11+1***	0+0	(11)	11+1	0+1	(8)
1/2 lb	-	1/2 oz	-	-	1 lb	-	-	4 lb 0.5%	0+0	-	10+1***	0+0	-	9+1	1+2	6+1
3/4 lb	-	3/4 oz	-	-	1 1/2 lb	-	-	6 lb 0.75%	0+0	-	9+1***	0+0	-	10+1	2+2	7+1
1 lb	-	1 oz	-	-	2 lb	-	-	8 lb 1%	0+0	-	12+2***	0+0	-	10+1	0+0	-
-	6 oz	1/4 oz	-	-	1/2 lb	-	-	2 lb 0.25%	0+0	-	13+1***	0+0	-	12+1	0+0	-
-	12 oz	1/2 oz	-	-	1 lb	-	-	4 lb 0.5%	0+0	-	13+2***	0+0	-	12+1	0+0	-
-	18 oz	3/4 oz	-	-	1 1/2 lb	-	-	6 lb 0.75%	0+0	-	11+1***	0+0	-	11+1	0+0	-
-	24 oz	1 oz	-	-	2 lb	-	-	8 lb 1%	0+0	-	10+0***	0+0	-	11+0	0+0	-

* Orchardgrass 1 seedhead/ft²; 18 inches tall
 ** Normal yellowing-not unsightly
 *** Very yellow-may be toxic at higher rates
 **** Embark = lb/A of mefluidide; X-77 = percent by volume of the total spray mix.
 Grass heights are given in inches.

Table 8. Effect of Embark + Telar in combination with Verdict, dinitrophenol (DNP), Poast, Crop Oil and Balan on seedhead formation in fescue, bluegrass and smooth brome. IN-126 test area. Applied April 17. Evaluation on May 30, 1987.

Embark	X-77	Telar	Amount per acre*				Fescue			Seedheads			Smooth Brome		
			Verdict	DNP	Poast	Crop Oil	Balan 2,4-D	Per ft. ²	Height**	Per ft. ²	Height	Per ft. ²	Height	Per ft. ²	Height
1/4 lb 0.25%	1/4 oz	-	-	-	-	-	-	10±2	36±1	2±1	23±1	11±6	43±11		
1/2 lb 0.5%	1/2 oz	-	-	-	-	-	2 lb	2±1	28±5	1±1	16±1	12±0	42±4		
3/4 lb 0.75%	3/4 oz	-	-	-	-	-	4 lb	1±1	27±6	4±2	17±1	3±2	37±3		
1 lb 1%	1 oz	-	-	-	-	-	6 lb	0±0	-	0±0	-	-	-		
1 lb 1%	1 oz	-	-	-	-	-	8 lb	0±0	-	0±0	-	-	-		
1/4 lb 0.25%	1/4 oz	-	1/2 lb	-	-	-	2 lb	2±1	33±3	2±1	20±1	5±3	38±2		
1/2 lb 0.5%	1/2 oz	-	1 lb	-	-	-	4 lb	2±2	26±3	5±2	20±2	3±2	36±4		
3/4 lb 0.75%	3/4 oz	-	1 1/2 lb	-	-	-	6 lb	1±1	20±2	0±1	(18)	0±1	28±2		
1 lb 1%	1 oz	-	2 lb	-	-	-	8 lb	0±1	14±2	0±0	-	3±3	22±2		
1/4 lb 0.25%	1/4 oz	-	1 lb	-	-	-	2 lb	4±1	29±3	1±1	18±3	4±2	38±2		
1/2 lb 0.5%	1/2 oz	-	2 lb	-	-	-	4 lb	3±1	31±3	4±1	18±2	3±2	42±6		
3/4 lb 0.75%	3/4 oz	-	3 lb	-	-	-	6 lb	1±1	16±6	1±1	15±2	-	-		
1 lb 1%	1 oz	-	4 lb	-	-	-	8 lb	0±0	-	0±0	-	-	-		
1/4 lb 0.25%	1/4 oz	-	1/16 lb	1 lb	-	-	2 lb	5±1	34±3	2±2	16±2	2±1	43±3		
1/2 lb 0.5%	1/2 oz	-	1/8 lb	2 lb	-	-	4 lb	3±0	28±2	3±1	18±2	1±2	26±4		
3/4 lb 0.75%	3/4 oz	-	3/16 lb	3 lb	-	-	6 lb	4±2	26±2	0±0	-	0±0	26±4		
1 lb 1%	1 oz	-	1/4 lb	4 lb	-	-	8 lb	1±1	11±3	0±0	-	0±0	TOXIC		
1/4 lb 0.25%	1/4 oz	-	-	1/2 lb	-	-	2 lb	0±0	-	0±0	-	0±1	(25)		
1/2 lb 0.5%	1/2 oz	-	-	1 lb	-	-	4 lb	0±0	DEAD	0±0	-	0±1	(25)		
3/4 lb 0.75%	3/4 oz	-	-	1 1/2 lb	-	-	6 lb	0±0	DEAD	0±0	DEAD	0±0	DEAD		
1 lb 1%	1 oz	-	-	2 lb	-	-	8 lb	0±0	DEAD	0±0	DEAD	0±0	DEAD		
1/4 lb 0.25%	1/4 oz	-	-	1/2 lb	1 qt	-	2 lb	0±0	DEAD	0±0	DEAD	3±3	(33)		
1/2 lb 0.5%	1/2 oz	-	-	1 lb	2 qt	-	4 lb	0±0	DEAD	0±0	DEAD	0±0	DEAD		
3/4 lb 0.75%	3/4 oz	-	-	1 1/2 lb	3 qt	-	6 lb	0±0	DEAD	0±0	DEAD	0±0	DEAD		
1 lb 1%	1 oz	-	-	2 lb	4 qt	-	8 lb	0±0	DEAD	0±0	DEAD	0±0	DEAD		
1/4 lb 0.25%	1/4 oz	-	-	-	-	-	4 lb	2±1	20±4	1±1	14±1	1±1	(33)		
1/2 lb 0.5%	1/2 oz	-	-	-	-	-	8 lb	1±1	16±2	0±0	-	0±0	-		
3/4 lb 0.75%	3/4 oz	-	-	-	-	-	12 lb	6 lb	19±3	0±0	-	-	-		
1 lb 1%	1 oz	-	-	-	-	-	16 lb	8 lb	19±3	0±0	-	-	-		

*Rates are in lb or oz per acre of active material except for X-77 surfactant which is % of total spray mixture.

**Grass height is in inches.

Table 8 Continued. Effect of treatments selected from 1984, 1985 and 1986 trials on seedhead suppression of smooth brome. Treatments applied April 20, 1987. Evaluation on May 17, 1987. IN 126 test area. Initial heights: smooth brome: 13 inches; fescue 11 inches; bluegrass 8 inches.

Amount per acre*															
Embark	Manage	Telar	Verdict	DNP	ton	Poast	an	2,4-D	X-77	Smooth Brome		Fescue		Bluegrass	
										Seedbeds Per ft ²	Blade Height	Seedbeds Per ft ²	Blade Height	Seedbeds Per ft ²	Blade Height
1/4 1b	-	1/4 oz	-	1 1b	-	-	-	2 1b	0.25%	6+2	25+2	16+0	11+2	2+2	12+1
1/2 1b	-	1/2 oz	-	2 1b	-	-	-	4 1b	0.5 %	3+0	24+4	15+2	11+2	2+2	12+2
3/4 1b	-	3/4 oz	-	3 1b	-	-	-	6 1b	0.75%	6+4	28+2	15+2	11+2	0+0	-
1 1b	-	1 oz	-	4 1b	-	-	-	8 1b	1 %	2+1	18+1	15+2	11+2	4+1	7+1
-	6 oz	1/4 oz	-	1 1b	-	-	-	2 1b	0.25%	2+1	24+2	13+1	12+1	1+0	12+1
-	12 oz	1/2 oz	-	2 1b	-	-	-	4 1b	0.5 %	3+3	20+5	13+1	13+1	2+2	10+1
-	18 oz	3/4 oz	-	3 1b	-	-	-	6 1b	0.75%	2+1	12+1	11+1	10+1	0+0	-
-	24 oz	1 oz	-	4 1b	-	-	-	8 1b	1 %	0+0	-	9+1	10+0	4+1	6+1
1/4 1b	-	1/4 oz	-	-	-	-	-	4 1b	0.25%	2+2	20+2	15+1	12+1	2+3	13+4
1/2 1b	-	1/2 oz	-	-	-	-	-	8 1b	0.5 %	0+1	19+1	11+1	11+1	2+3	9+1
3/4 1b	-	3/4 oz	-	-	-	-	-	12 1b	0.75%	0+2	18+2	9+2	10+1	1+1	10+1
1 1b	-	1 oz	-	-	-	-	-	16 1b	1 %	0+0	-	10+1	9+1	4+3	10+2
-	6 oz	1/4 oz	-	-	-	-	-	4 1b	0.25%	1+1	16+4	11+2	12+1	1+0	10+3
-	12 oz	1/2 oz	-	-	-	-	-	8 1b	0.5 %	0+0	-	10+1	12+1	0+0	-
-	18 oz	3/4 oz	-	-	-	-	-	12 1b	0.75%	0+0	-	10+1	8+2	0+0	-
-	24 oz	1 oz	-	-	-	-	-	16 1b	1 %	0+0	-	10+1	9+1	2+2	8+0

* Embark = 1b/A of metfluidide; X-77 = percent by volume of the total spray mixture; all other materials are oz/A or 1b/A of active materials.
Grass heights are given in inches

Table 9. Embark alone, Embark plus Telar and Embark plus Verdict at varying rates with X-77 Surfactant and 2,4-D or Verdict alone on seedhead formation in fescue and bluegrass. IN-126 test area. Applications on April 23, 1987. Evaluations on June 15, 1987. Initial grass heights: fescue 13 inches, bluegrass 8 inches.

Embark	Amount*				Seedheads**			
	X-77	Telar	Verdict	2,4-D	Fescue		Bluegrass	
					Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	13+1	45+5	3+1	23+0
1/4 lb	0.25%	1/4 oz	-	2 lb	2+2	25+2	1+1	13+1
1/2 lb	0.5 %	1/2 oz	-	4 lb	0+0	-	0+0	-
3/4 lb	0.75%	3/4 oz	-	6 lb	2+2	15+1	0+0	-
1 lb	1 %	1 oz	-	8 lb	0+1	(22)	1+1	11+2
1/4 lb	0.25%	-	-	2 lb	4+1	35+3	3+1	20+4
1/2 lb	0.5 %	-	-	4 lb	2+1	36+2	3+1	23+4
3/4 lb	0.75%	-	-	6 lb	3+1	22+2	2+1	21+2
1 lb	1 %	-	-	8 lb	2+1	(22)	0+0	-
1/4 lb	0.25%	-	1/32 lb	2 lb	6+2	39+2	2+1	24+2
1/2 lb	0.5 %	-	1/16 lb	4 lb	4+2	36+2	0+0	-
3/4 lb	0.75%	-	3/32 lb	6 lb	3+1	31+4	0+0	-
1 lb	1 %	-	1/8 lb	8 lb	3+1	35+3	4+2	15+1
1/4 lb	0.25%	-	1/16 lb	2 lb	6+3	38+3	3+2	26+4
1/2 lb	0.5 %	-	1/8 lb	4 lb	4+2	31+3	1+1	(16)
3/4 lb	0.75%	-	3/16 lb	6 lb	3+1	36+2	0+0	-
1 lb	1 %	-	1/4 lb	8 lb	3+2	34+2	1+0	10+2
1/4 lb	0.25%	-	1/8 lb	2 lb	4+1	35+3	2+1	19+4
1/2 lb	0.5 %	-	1/4 lb	4 lb	2+1	36+2	0+1	(11)
3/4 lb	0.75%	-	3/8 lb	6 lb	2+2	34+2	2+1	18+2
1 lb	1 %	-	1/2 lb	8 lb	1+1	20+2	2+1	12+2
-	0.25%	-	1/32 lb	-	10+2	38+2	2+1	23+4
-	0.25%	-	1/16 lb	-	10+2	43+4	4+1	27+2
-	0.25%	-	3/32 lb	-	10+2	35+3	1+1	(23)
-	0.25%	-	1/8 lb	-	12+2	40+1	4+2	25+1
-	0.5 %	-	1/8 lb	-	6+3	37+5	2+1	26+2
-	1 %	-	1/8 lb	-	3+1	30+2	0+0	-
-	0.25%	-	3/16 lb	-	10+3	40+4	2+1	20+3
-	0.25%	-	1/4 lb	-	10+2	37+1	3+1	22+2
-	0.5 %	-	1/4 lb	-	6+4	36+2	2+1	18+3
-	1 %	-	1/4 lb	-	8+2	31+3	2+2	20+2
-	0.5 %	-	3/8 lb	-	12+2	41+5	4+2	23+2
-	0.5 %	-	1/2 lb	-	10+2	40+3	2+1	20+2
-	0.75%	-	3/4 lb	-	4+2	37+2	0+0	-
-	1 %	-	1 lb	-	5+3	35+2	0+0	***

* Amount is in oz per acre or lb per acre of active ingredient except for X-77 Surfactant which is % by volume of the total spray mixture.

** Seedhead height is in inches.

*** Borderline toxicity to bluegrass.

Table 10. Manage with varying concentrations of Verdict with and without 2,4-D in comparison to Manage plus Telar. Applications on April 24, 1987. Evaluations on June 22, 1987. IN-126 test area.

Manage	Amount*				Seedheads**		Bluegrass		
	X-77	Telar	Verdict	2,4-D	Fescue Per ft ²	Height	Per ft ²	Height	
-	-	-	-	-	13+1	44+3	7+4	26+2	
4 oz	0.25%	1/4 oz	-	2 lb	4+1	32+2	2+1	15+1	Toxi
8 oz	0.5 %	1/2 oz	-	4 lb	2+2	20+4	1+1	10+2	
4 oz	0.25%	-	-	2 lb	5+3	29+1	4+4	14+1	
8 oz	0.5 %	-	-	4 lb	2+0	10+2	11+2	12+4	
4 oz	0.25%	-	1/32 lb	2 lb	7+2	33+2	3+1	14+2	
8 oz	0.5 %	-	1/16 lb	4 lb	3+1	31+3	1+1	16+2	
4 oz	0.25%	-	1/16 lb	2 lb	4+4	30+2	4+4	16+3	
8 oz	0.5 %	-	1/8 lb	4 lb	1+2	26+3	6+3	13+2	
4 oz	0.25%	-	1/8 lb	2 lb	3+1	27+3	2+2	17+1	Toxi
8 oz	0.5 %	-	1/4 lb	4 lb	3+2	27+2	1+1	11+2	
-	0.25%	-	1/32 lb	-	12+3	42+1	6+3	27+1	
-	0.25%	-	1/16 lb	-	14+2	44+4	6+4	27+1	
-	0.25%	-	1/8 lb	-	10+4	41+3	4+1	21+2	
-	0.25%	-	1/4 lb	-	3+1	34+2	3+2	17+4	
-	0.25%	-	1/2 lb	-	2+2	32+1	2+2	14+1	
-	0.25%	-	1 lb	-	0+1	(18)	0+1	(11)	Toxi

* Amounts are in oz per acre or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture

** Grass heights are in inches plus or minus standard deviations among 4 replications of 3' X 6' plots.

Table 11.

Embank or Manage in combination with Telar, 4-nitrophenylacetate (4-NPAC) and 5-nitroquinline-N-oxide (5-NQNO) on seedhead formation in Fescue, Bluegrass and Smooth Brome. IN 126 test area. Application on April 24, 1987. Evaluation on June 1, 1987. Initial heights: fescue 13 inches, blue grass, 9 inches, smooth brome 13 inches.

Embank	Manage	Amount per acre*		4-NPAC	5-NQNO	2:4:D	Fescue		Bluegrass		Seedheads**		Smooth Brome		Orchard grass	
		X-77	Telar				Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
1/4 lb	-	0.25%	1/4 oz	-	-	2 lb	14+2	41+6	5+3	21+4	8+3	38+6			3	31
1/2 lb	-	0.5%	1/2 oz	-	-	4 lb	2+0	23+2	3+3	13+3	6+5	36+2				
3/4 lb	-	0.75%	3/4 oz	-	-	6 lb	0+0	15+2	1+1	14+1	8+4	30+4				
1 lb	-	1%	1 oz	-	-	8 lb	0+0	(14)	0+0	-	NOT TOXIC					
-	3 oz	0.25%	1/4 oz	-	-	2 lb	6+2	28+4	5+3	13+1	3+3	19+6				
-	6 oz	0.5%	1/2 oz	-	-	4 lb	5+4	22+6	1+1	12+0	6+3	36+6				
-	9 oz	0.75%	3/4 oz	-	-	6 lb	3+2	16+2	0+0	-						
-	12 oz	1%	1 oz	-	-	8 lb	2+2	18+6	0+1	8+1						
-	-	0.25%	1/4 oz	-	-	2 lb	8+4	29+4	2+2	20+2	7+8	33+4			2	35
-	-	0.5%	1/2 oz	-	-	4 lb	4+3	31+4	3+1	22+2	8+2	24+8				
-	-	0.75%	3/4 oz	-	-	6 lb	2+1	17+2	1+1	12+2						
-	-	1%	1 oz	-	-	8 lb	1+1	15+2	0+0	-						
1/4 lb	-	0.25%	-	1 lb	-	-	11+1	32+6	4+2	23+1	8+4	35+1				
1/2 lb	-	0.5%	-	2 lb	-	-	2+2	26+4	1+1	22+2	12+4	38+3				
3/4 lb	-	0.75%	-	3 lb	-	-	0+1	(8)	0+1	(10)						
1 lb	-	1%	-	4 lb	-	-	12+2	41+6	0+0	(8)						
-	3 oz	0.25%	-	1 lb	-	-	14+2	37+1	3+1	16+1	12+4	46+4				
-	6 oz	0.5%	-	2 lb	-	-	3+3	23+2	0+0	-	12+4	36+4				
-	9 oz	0.75%	-	3 lb	-	-	2+2	15+3	0+0	-						
-	12 oz	1%	-	4 lb	-	-	14+2	47+1	5+1	20+5	14+2	41+5			3	40
-	-	0.25%	-	1 lb	-	-	13+5	38+2	0+0	-	12+2	38+4				
-	-	0.5%	-	2 lb	-	-	3+3	36+6	1+1	(17)						
-	-	0.75%	-	3 lb	-	-	1+1	16+2	0+0	-						
1/4 lb	-	0.25%	-	1 lb	-	-	14+0	47+2	10+2	20+2	16+4	51+6				
1/2 lb	-	0.5%	-	2 lb	-	-	13+1	41+4	6+4	19+2	16+4	51+6				
3/4 lb	-	0.75%	-	3 lb	-	-	10+2	35+2	1+1	22+2						
1 lb	-	1%	-	4 lb	-	-	7+1	25+2	1+2	17+5						
-	3 oz	0.25%	-	1 lb	-	-	9+6	37+5	3+1	18+0	8+6	40+3				
-	6 oz	0.5%	-	2 lb	-	-	11+1	41+5	4+0	21+2	12+0	39+3				
-	9 oz	0.75%	-	3 lb	-	-	12+2	33+1	3+1	20+2						
-	12 oz	1%	-	4 lb	-	-	8+2	27+1	1+1	8+1						
-	-	0.25%	-	1 lb	-	-	14+2	41+3	4+2	19+8	12+2	40+10				
-	-	0.5%	-	2 lb	-	-	17+1	41+5	2+1	24+2	14+4	39+3				
-	-	0.75%	-	3 lb	-	-	11+1	27+2	0+0	-						
-	-	1%	-	4 lb	-	-	6+2	22+2	0+0	-						

* Amounts are pounds or ounces per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture. ** Grass heights in inches.

Table 12. Effect of varying rates of garlon in the presence of Manage, Verdict and X-77 surfactant with or without 2,4-D on seedhead formation in fescue, bluegrass, smooth brome, quackgrass and orchardgrass. Treatments applied April 27, 1987. Evaluations on June 13, 1987. Initial heights, fescue 13-15 inches, bluegrass, 12 inches and heading and smooth brome 19 inches.

Manage	X-77	Garlon	Verdict	2,4-D	Amount*		Fescue		Bluegrass		Smooth Brome		Quackgrass		Orchardgrass		Bluegrass Toxicity*
							Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	
-	-	-	-	-	13+1	47+1	4+2	32+4	1+1	46+2	4+2	36+4	4	50	-	-	-
4 oz	0.25%	-	-	-	7+4	33+5	4+2	18+3	3+1	37+1	6+2	34+4					+
4 oz	0.25%	-	-	2 lb	5+3	26+7	1+1	18+2	4+2	37+1	6+2	32+4					+
4 oz	0.25%	2 lb	1/32 lb	-	6+0	33+2	3+1	16+2	4+2	28+8	6+2	36+2					+
4 oz	0.25%	1 lb	1/32 lb	-	4+1	30+4	4+0	16+2	3+1	33+1	6+3	36+4					+
4 oz	0.25%	1/2 lb	1/32 lb	-	8+0	29+2	3+0	16+4	0+0	-							+++
4 oz	0.25%	1/2 lb	1/32 lb	2 lb	4+0	27+4	4+1	14+2	1+1	32+4			0	-			+
4 oz	0.25%	1/4 lb	1/32 lb	-	9+3	34+4	4+1	15+3	2+0	29+0			0	-			+
4 oz	0.25%	1/8 lb	1/32 lb	-	6+2	30+3	3+1	16+3	4+0	31+2							+

* Amounts were oz/A or lb/A of active materials except for X-77 surfactant which was percent by volume of the total spray mixture.

** Grass height in inches. Plots were 3 ft X 6 ft with 4 replicates except for replicate IV where the plots were 6 ft X 12 ft.

*** Treatments were toxic to bluegrass. All treatments were toxic but not in all plots. Seemed to be related to the Manage rather than to either the Garlon or the Verdict.

Table 13. Effect of varying rates of Manage and Telar in the presence of X-77 surfactant and 2,4-D amine. IN-216 test area. Applications were on April 28, 1987. Evaluations on June 14, 1987. Initial heights, fescue 16 in, bluegrass 12 inches, smooth brome 19 inches, orchardgrass, 20 inches.

Manage	Amount*			Fescue		Bluegrass		SEEDHEADS** Smooth Brome		Orchardgrass		Bluegrass Toxicity
	X-77	Telar	2,4-D	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	
-	-	-	-	13+1	45+6	4+0	31+2	11+1	49+4	2+0	38+0	-
6 oz	0.25%	-	2 lb	6+0	28+4	5+1	15+3	1+1	19+1	0	-	Very Toxic
6 oz	0.25%	1/8 oz	2 lb	3+1	24+2	3+0	16+2	0+0	-	0	-	Very Toxic
6 oz	0.25%	1/4 oz	2 lb	2+1	21+2	1+1	12+2	0+2	(31)	0	-	Very Toxic
4 oz	0.25%	-	2 lb	4+2	32+6	3+1	17+3	0+0	-	1+1	(26)	Toxic
4 oz	0.25%	1/16 oz	2 lb	6+2	26+7	2+1	16+2	1+1	(24)	-	-	Toxic
4 oz	0.25%	1/8 oz	2 lb	4+2	27+3	3+2	17+1	1+2	35+2	0	-	Very Toxic
4 oz	0.25%	1/4 oz	2 lb	5+1	29+3	3+1	16+1	2+0	29+6	1	21	Very Toxic
4 oz	0.25%	3/8 oz	2 lb	6+2	30+8	3+1	17+3	1+2	36+1	1+1	(16)	Very Toxic
3 oz	0.25%	1/4 oz	2 lb	6+2	27+5	3+2	15+3	4+2	35+5	1	28	Not immediately Toxic

*Amounts are in oz per acre or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

** Seedhead heights are in inches plus or minus standard deviations. Plots were 3 ft X 6 feet and replicated four times. Plots in replicate IV were 6 ft X 12 ft.

Table 14.

Effect of treatments selected from 1984, 1985 and 1986 trials on seedhead suppression of smooth brome. Treatments applied on April 30, 1987. Evaluation on May 18, 1987. IN 126 test area. Initial heights: smooth brome 17 inches; fescue, 17 inches; bluegrass 10 inches; orchardgrass, 18 inches

Embark	K-77	Amount per acre*			Roast	Smooth Brome		Fescue		Bluegrass			
		Telar	Premerge	EL 107		Seedheads Per ft. ²	Height	Seedheads Per ft. ²	Height	Seedheads Per ft. ²	Height		
-	-	-	-	-	-	4+2	26+2	15+1	6+2	33+1	12+1	1+1	17+2
1/4 lb	0.25%	1/4 oz	-	-	-	4+2	22+2	15+1	3+2	21+2	14+2	1+1	17+1
1/2 lb	0.5 %	1/2 oz	-	-	-	4 lb	25+2	15+1	4+2	21+2	13+1	1+1	13+2
3/4 lb	0.75%	3/4 oz	-	-	-	6 lb	25+2	15+2	1+1	19+1	18+2	1+2	25+2
1 lb	1 %	1 oz	-	-	-	8 lb	25+2	16+1	0+0	-	14+1	2+1	24+2
1/4 lb	0.25%	1/4 oz	1/4 lb	-	-	5+2	27+2	14+2	3+3	20+2	15+3	2+2	19+3
1/2 lb	0.5 %	1/2 oz	1/2 lb	-	-	5+2	27+2	14+1	3+3	18+2	14+2	3+3	20+3
3/4 lb	0.75%	3/4 oz	3/4 lb	-	-	6 lb	24+2	15+1	1+1	15+1	15+1	3+3	17+2
1 lb	1 %	1 oz	1 lb	-	-	8 lb	22+2	15+1	0+0	-	16+2	5+2	15+1
1/4 lb	0.25%	1/4 oz	1/2 lb	-	-	6+2	25+2	17+1	3+2	17+2	16+2	1+1	13+2
1/2 lb	0.5 %	1/2 oz	1 lb	-	-	4+1	22+2	16+2	1+1	17+2	16+2	1+1	19+2
3/4 lb	0.75%	3/4 oz	1 1/2 lb	-	-	6 lb	3+3	19+1	1+0	19+2	18+2	1+1	20+2
1 lb	1 %	1 oz	2 lb	-	-	8 lb	2+2	20+2	0+0	-	16+2	3+2	11+2
1/4 lb	0.25%	1/4 oz	1 lb	-	-	5+4	25+2	15+2	1+2	15+1	16+2	1+1	17+2
1/2 lb	0.5 %	1/2 oz	2 lb	-	-	5+3	23+3	16+1	3+3	16+1	15+2	1+1	19+2
3/4 lb	0.75%	3/4 oz	3 lb	-	-	6 lb	5+2	25+2	17+2	0+0	-	3+2	20+2
1 lb	1 %	1 oz	4 lb	-	-	8 lb	5+2	25+2	18+2	0+0	-	2+1	25+2
1/4 lb	0.25%	1/4 oz	-	1 lb	-	3+2	31+2	16+1	3+3	18+2	16+1	1+1	17+1
1/2 lb	0.5 %	1/2 oz	-	2 lb	-	3+2	31+3	16+1	1+1	16+2	15+1	2+2	15+1
3/4 lb	0.75%	3/4 oz	-	3 lb	-	1+1	31+3	16+1	0+1	(18)	16+2	1+1	18+2
1 lb	1 %	1 oz	-	4 lb	-	0+1	24+2	17+1	2+2	15+1	16+1	1+1	16+2
1/4 lb	0.25%	1/4 oz	-	2 lb	-	2+2	30+2	16+1	3+3	20+2	16+1	2+2	16+2
1/2 lb	0.5 %	1/2 oz	-	4 lb	-	2+2	28+3	16+1	0+0	-	16+1	3+2	20+2
3/4 lb	0.75%	3/4 oz	-	6 lb	-	0+1	27+0	17+1**	0+0	-	16+1**	3+2	23+2
1 lb	1 %	1 oz	-	8 lb	-	0+1	26+1	16+1**	0+0	-	20+1**	1+2	20+2

*Embark = 1b/A mefluidide; X-77 = percent by volume of the total spray mixture. All other materials were oz/A or 1b/A of active materials. Grass heights are given in inches.

**Slight discoloration (yellowing) especially of fescue.

Table 14 . (Continued) . Effect of treatments selected from 1984, 1985 and 1986 trials on seedhead suppression of smooth brome. Treatments applied on April 30, 1987. Evaluations on May 18 and 19, 1987. IN 126 test area. Initial heights: smooth brome 17 inches; fescue, 17 inches; bluegrass 10 inches; orchardgrass, 18 inches

Embark	X-77	Telar	Amount per acre*				Smooth Brome			Fescue			Bluegrass		
			Premerge	EL 107	Poast	2,4-D	Seedheads Per ft ²	Height	Blade Height	Seedheads Per ft ²	Height	Blade Height	Seedheads Per ft ²	Height	Blade Height
1/4 lb	0.25%	1/4 oz	-	-	0.75 lb	2 lb	1+1	27+1	17+1	0+0	-	16+1	2+2	18+1	
1/2 lb	0.5 %	1/2 oz	-	-	1.5 lb	4 lb	0+1	25+2	17+1	0+1	19+2	17+1	1+1	14+2	
3/4 lb	0.75%	3/4 oz	-	-	2.25 lb	6 lb	0+0	-	17+0**	0+0	-	17+1**	1+1	16+1	
1 lb	1 %	1 oz	-	-	3 lb	8 lb	0+0	-	17+0**	0+0	-	17+1**	4+1	16+1	
1/4 lb	0.25%	1/4 oz	-	-	1 lb	2 lb	3+3	30+2	16+2	0+0	-	15+1	1+1	16+2	
1/2 lb	0.5 %	1/2 oz	-	-	2 lb	4 lb	1+1	25+2	17+2	0+0	-	17+1	1+1	17+1	
3/4 lb	0.75%	3/4 oz	-	-	3 lb	6 lb	0+0	-	18+1**	0+0	-	16+1	4+1	18+1**	
1 lb	1 %	1 oz	-	-	4 lb	8 lb	0+0	-	17+1**	0+0	-	15+1	4+1	18+2**	

*Embark = 1b/A mefluidide; X-77 = percent by volume of the total spray mixture. All other materials were oz/A or 1b/A of active materials.

Grass heights are in inches

**Extensive discoloration of foliage (yellowing).

Table 15 Embark plus Telar or Embark plus Garlon and Verdict at varying rates in combination with X-77 surfactant and 2,4-D on seedhead suppression in fescue, smooth brome and bluegrass. IN-126 test area. Application on April 29, 1987. Evaluation on June 22, 1987. Initial grass heights, Fescue, 12-16 in; smooth brome, 17 in; orchard grass, 16 in; bluegrass 13 in, 18 seedheads/ft².

Embark	X-77	Telar	Amount*		2,4-D	Fescue		Seedheads**		Smooth, Brome	
			Garlon	Verdict		Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	11+1	43+4	7+4	29+3	4+1	45+2
1/8 lb	0.25%	1/8 oz	-	-	2 lb	0+0	-	7+3	20+2	1+1	(32)
1/4 lb	0.25%	1/4 oz	-	-	2 lb	0+0	-	6+4	15+3		
1/2 lb	0.5 %	1/2 oz	-	-	4 lb	0+0	-	3+2	14+2		
1/4 lb	0.25%	-	2 lb	1/32 lb	-	3+1	34+8	5+3	21+1		
1/2 lb	0.5 %	-	4 lb	1/16 lb	-	3+2	33+3	3+1	21+2		
1/4 lb	0.25%	-	1 lb	1/32 lb	-	3+1	31+6	8+4	21+1	0+0	-
1/2 lb	0.5 %	-	2 lb	1/16 lb	-	4+2	34+3	2+1	17+3		
1/4 lb	0.25%	-	1/2 lb	1/32 lb	-	4+1	33+3	8+6	22+4		
1/2 lb	0.5 %	-	1 lb	1/16 lb	-	2+2	32+4	3+1	21+4		
1/4 lb	0.25%	-	1/2 lb	1/32 lb	2 lb	9+3	38+2	5+1	20+1	0+0	-
1/2 lb	0.5 %	-	1 lb	1/16 lb	4 lb	3+1	32+2	4+2	18+3		
1/4 lb	0.25%	-	1/4 lb	1/32 lb	-	10+2	37+8	13+1	22+1		
1/2 lb	0.5 %	-	1/2 lb	1/16 lb	-	3+1	27+3	4+2	17+3		
1/4 lb	0.25%	-	1/8 lb	1/32 lb	-	11+3	37+5	13+1	18+1		
1/2 lb	0.5 %	-	1/4 lb	1/16 lb	-	3+1	34+3	10+2	18+3		

* Amount is in oz per acre or lb per acre except for X-77 surfactant which is percent by volume of the total spray mixture.

** Seedhead height is in inches plus or minus standard deviation.

Table 16. Embark plus Telar in the presence of X-77 Surfactant and 2,4-D with or without ACP 1900 compared to Manage plus Telar. IN-126 test area. Application on April 30, 1987. Evaluation on June 25, 1987. Initial grass heights fescue 16 inches, bluegrass 12 inches (16 seedheads/ft²), orchardgrass, 17 inches.

Embark	Manage	Amount*		ACP 1900	2,4-D	Seedheads**			
		Telar	X-77			Fescue	Bluegrass		
						Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	15+1	46+3	7+2	26+5
1/4 lb	-	1/4 oz	0.25%	-	2 lb	1+1	(28)	7+3	14+3***
1/2 lb	-	1/2 oz	0.5 %	-	4 lb	0+0	-	4+3	12+2
1/4 lb	-	-	0.25%	1/8 oz	2 lb	5+1	29+3	11+5	23+4
1/2 lb	-	-	0.5 %	1/4 oz	4 lb	4+2	27+2	12+4	19+2
-	-	-	0.25%	1/4 oz	2 lb	8+4	33+3	8+4	26+2
-	-	-	0.5 %	1/2 oz	4 lb	8+2	36+6	8+4	29+3
-	-	1/4 oz	0.25%	1/8 oz	2 lb	4+2	29+2	6+2	23+1
-	-	1/2 oz	0.25%	1/4 oz	4 lb	1+1	27+4	8+4	25+3
-	4 oz	-	0.25%	-	2 lb	6+1	29+0	4+4	17+2
-	8 oz	-	0.5 %	-	4 lb	2+2	28+4	0+0	-
-	4 oz	1/4 oz	0.25%	-	2 lb	3+1	28+2	6+6	13+3
-	8 oz	1/2 oz	0.5 %	-	4 lb	2+2	22+2	0+1	8+2 Toxic

* Amounts are in pounds or ounces of active ingredient per acre except for X-77 Surfactant which is percent by volume of the total spray mixture.

** Grass height in inches + standard deviation from three replicate plots.

*** Orchardgrass 2 seedheads/ft²; height 27 inches.

Table 17. Preliminary evaluation of experimental materials Mon 4625, Mon 4629, p-nitrophenylacetate and 8-hydroxyquinoline-N-oxide at varying rates on seedhead formation and growth of fescue. Treatments applied May 4, 1987. Evaluations on June 26, 1987. IN 126 test area.

Mon 4625	Amount*		8-hydroxy-quinoline-N-oxide	Seedheads**			
	Mon 4629	p-nitrophenyl-acetate		Fescue		Bluegrass	
				Per ft ²	Height	Per ft ²	Height
-	-	-	-	15+3	45+1	9+3	29+1
1 lb	-	-	-	13+1	43+2	11+6	26+3
2 lb	-	-	-	13+3	44+3	8+4	25+4
3 lb	-	-	-	14+2	43+3	11+5	24+1
4 lb	-	-	-	14+0	39+3	11+5	23+4
-	1 lb	-	-	14+2	43+1	8+2	26+1
-	2 lb	-	-	14+2	44+1	14+2	25+3
-	3 lb	-	-	14+0	43+4	9+3	21+9
-	4 lb	-	-	13+2	44+2	10+4	28+2
-	-	1 lb	-	15+1	42+2	10+2	26+2
-	-	2 lb	-	15+3	44+3	8+4	27+2
-	-	3 lb	-	16+2	43+1	8+4	27+2
-	-	4 lb	-	11+4	41+4	6+3	25+3
-	-	-	1 lb	16+2	41+1	11+5	25+3
-	-	-	2 lb	15+3	41+0	12+3	25+3
-	-	-	3 lb	16+2	42+1	11+5	26+1
-	-	-	4 lb	11+5	44+3	4+1	24+3

* Amounts are pounds per acre of active material

** Seedhead heights are measured in inches

Table 18. Embark (1/8 lb/A) in combination with varying rates of Telar plus X-77 Surfactant (0.25%) and 2,4-D amine (2 lb/A) on seedhead formation in fescue. IN-126 test area. Application on April 30, 1987. Evaluation on June 25, 1987. Initial grass heights fescue 13 inches; bluegrass 12 inches (2-12 seedheads per ft²).

Embark	Amount*			Seedheads**			
	Telar	X-77	2,4-D	Fescue		Bluegrass	
				Per ft ²	Height	Per ft ²	Height
-	-	-	-	15+1	43+1	4+1	24+7
1/8 lb	-	0.25%	2 lb	5+1	34+4	3+2	17+4
1/8 lb	1/32 oz	0.25%	2 lb	4+0	26+4	3+2	16+2
1/8 lb	1/16 oz	0.25%	2 lb	3+1	24+5	5+1	19+2
1/8 lb	3/32 oz	0.25%	2 lb	2+1	23+3	3+2	19+1
1/8 lb	1/8 oz	0.25%	2 lb	2+2	20+1	5+1	17+1
1/8 lb	5/32 oz	0.25%	2 lb	1+1	23+2	4+1	17+1
1/8 lb	1/4 oz	0.25%	2 lb	1+0	18+4	3+1	17+1

* Amount is lb/A or oz/A of active ingredient except for X-77 surfactant which is in percent by volume of the total spray mixture

** Seedhead height is in inches.

Table 19. Effect of Embark and Manage in combination with Telar, Tridiphane, Chloryralid, Trichlopyr and 2,4-D on seedhead suppression of fescue, bluegrass and smooth brome. IN-126 test area. Application on May 1, 1987. Evaluation on June 3, 1987.

Embark	Manage	Amount*				Fescue		Seedheads**		Smooth Brome	
		X-77	Tridiphane	Chloryralid	Trichlopyr	2,4-D	Per ft ² Height	Bluegrass	Per ft ² Height	Per ft ² Height	Per ft ² Height
-	-	-	-	-	-	-	15+1	3+2	23+5	12+1	39+1
1/4 lb	-	0.25% 1/4 oz	-	-	-	2 lb	0+0	2+1	19+4	11+1	38+2
1/2 lb	-	0.5 % 1/2 oz	-	-	-	4 lb	0+0	3+2	10+4	-	-
3/4 lb	-	0.75% 3/4 oz	-	-	-	6 lb	0+0	3+1	7+4	-	-
1 lb	-	1 % 1 oz	-	-	-	8 lb	0+0	2+1	8+2	-	-
1/4 lb	-	0.25% 1/4 oz	-	1/4 lb	1/4 lb	1 lb	0+1	3+1	15+1	3+1	37+4
1/2 lb	-	0.5 % 1/2 oz	-	1/2 lb	1/2 lb	2 lb	0+0	1+1	9+1	-	-
3/4 lb	-	0.75% 3/4 oz	-	3/4 lb	3/4 lb	3 lb	0+0	0+0	-	-	-
1 lb	-	1 % 1 oz	-	1 lb	1 lb	4 lb	0+0	0+0	-	-	-
1/4 lb	-	0.25% 1/4 oz	-	1/2 lb	1/2 lb	1 lb	0+0	3+2	18+2	6+2	34+7
1/2 lb	-	0.5 % 1/2 oz	-	1 lb	1 lb	2 lb	0+0	2+1	12+2	-	-
3/4 lb	-	0.75% 3/4 oz	-	1 1/2 lb	1 1/2 lb	3 lb	0+0	5+4	12+1	-	-
1 lb	-	1 % 1 oz	-	2 lb	2 lb	4 lb	0+0	8+4	10+2	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.25% 1/4 oz	-	-	-	2 lb	0+1	3+1	17+2	3+1	31+2
-	-	0.5 % 1/2 oz	-	-	-	4 lb	0+0	0+1	(8)	-	-
-	-	0.75% 3/4 oz	-	-	-	6 lb	0+0	-	-	-	-
-	-	1 % 1 oz	-	-	-	8 lb	0+0	0+0	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.25% 1/4 oz	-	1/4 lb	1/4 lb	1 lb	2+1	3+1	11+2	3+1	27+3
-	-	0.5 % 1/2 oz	-	1/2 lb	1/2 lb	2 lb	3+1	1+1	11+1	1+1	18+3
-	-	0.75% 3/4 oz	-	3/4 lb	3/4 lb	3 lb	0+1	0+0	-	-	-
-	-	1 % 1 oz	-	1 lb	1 lb	4 lb	0+0	0+0	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.25% 1/4 oz	-	1/2 lb	1/2 lb	1 lb	3+1	6+1	15+3	4+0	31+1
-	-	0.5 % 1/2 oz	-	1 lb	1 lb	2 lb	2+2	0+0	-	-	-
-	-	0.75% 3/4 oz	-	1 1/2 lb	1 1/2 lb	3 lb	0+0	0+0	-	-	-
-	-	1 % 1 oz	-	2 lb	2 lb	4 lb	0+0	0+0	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
1/4 lb	-	0.25% 1/4 oz	-	1/2 lb	1/2 lb	2 lb	10+3	3+1	20+3	12+2	38+2
1/2 lb	-	0.5 % 1/2 oz	-	1 lb	1 lb	4 lb	5+3	4+1	18+3	-	-
3/4 lb	-	0.75% 3/4 oz	-	1 1/2 lb	1 1/2 lb	6 lb	1+1	24+5	18+2	-	-
1 lb	-	1 % 1 oz	-	2 lb	2 lb	8 lb	1+1	24+7	0+0	-	-
-	-	0.25% 1/4 oz	-	1/2 lb	1/2 lb	2 lb	4+3	29+3	16+1	5+1	27+3
-	-	0.5 % 1/2 oz	-	1 lb	1 lb	4 lb	1+1	24+2	9+3	-	-
-	-	0.75% 3/4 oz	-	1 1/2 lb	1 1/2 lb	6 lb	1+1	17+3	-	-	-
-	-	1 % 1 oz	-	2 lb	2 lb	8 lb	1+1	14+10	0+0	-	-

* Amount is in lb or oz per acre except for X-77 surfactant which is percent by volume of the total spray mixture.

** Grass height is in inches.

Table 20. Embark or Manage with and without various hydroxyquinoline derivatives in the presence of X-77 Surfactant and 2,4-D on seedhead formation in fescue and bluegrass. IN-126 test area. Applied on May 4, 1987. Evaluation on June 16, 1987.

Amount*							Seedheads**			
Embark	Manage	8-Hydroxy-quinoline-		8-Hydroxy-quinoline	2-Hydroxy-quinoline	2,4-D	Fescue		Bluegrass	
		X-77	N-oxide				Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	-	14+2	48+1	3+2	27+2
1/4 lb	-	0.25%	-	-	-	2 lb	8+2	33+3	1+1	17+4
1/2 lb	-	0.5 %	-	-	-	4 lb	6+3	33+3	2+1	13+2
3/4 lb	-	0.75%	-	-	-	6 lb	4+2	28+2	0+0	-
-	4 oz	0.25%	-	-	-	2 lb	8+4	31+3	1+1	16+0
-	8 oz	0.5 %	-	-	-	4 lb	1+1	21+2	0+1	9+2
-	12 oz	0.75%	-	-	-	6 lb	0+1	17+2	0+0	-
-	-	0.25%	1 lb	-	-	2 lb	14+2	47+0	3+1	23+2
-	-	0.5 %	2 lb	-	-	4 lb	16+2	50+4	2+1	25+2
-	-	0.75%	3 lb	-	-	6 lb	12+3	50+4	2+1	31+4
1/4 lb	-	0.25%	1 lb	-	-	2 lb	10+3	31+6	2+1	18+3
-	4 oz	0.25%	1 lb	-	-	2 lb	9+3	32+7	2+1	21+5
-	-	0.25%	-	1 lb	-	2 lb	15+1	47+1	3+1	24+4
-	-	0.5 %	-	2 lb	-	4 lb	14+4	46+3	4+2	21+2
-	-	0.75%	-	3 lb	-	6 lb	14+2	46+4	2+1	18+2
1/4 lb	-	0.25%	-	1 lb	-	2 lb	9+3	37+9	3+1	23+4
-	4 oz	0.25%	-	1 lb	-	2 lb	5+1	31+3	0+1	15+1
-	-	0.25%	-	-	1 lb	2 lb	14+2	41+6	2+1	23+3
-	-	0.5 %	-	-	2 lb	4 lb	14+2	46+3	4+2	21+2
-	-	0.75%	-	-	3 lb	6 lb	14+2	46+4	2+1	21+3
1/4 lb	-	0.25%	-	-	1 lb	2 lb	11+1	35+1	2+2	13+2
-	4 oz	0.25%	-	-	1 lb	2 lb	6+4	33+4	3+1	14+2

* Pounds per acre or ounces per acre of active ingredient except for X-77 surfactant which is percent, by volume, of the total spray mixture.

**Grass heights are in inches. Average of three replicate 3' X 6' plots \pm standard deviations.

Table 21. Fescue, bluegrass, smooth bromine and orchardgrass. Sprayed May 4, 1987. Evaluation on June 4, 1987. IN 126 test area.

Embank	Manage	Amount* X-77	Telar	Balan	Sanalan	2,4-D	Seedheads**			
							Fescue Per ft ²	Bluegrass Per ft ²	Smooth Bromine Per ft ²	Orchardgrass Per ft ²
							Height	Height	Height	Height
-	-	-	-	-	-	-	16+2	45+3	3+1	24+2
1/4 lb	-	0.25%	1/4 oz	-	-	2 lb	0+0	-	3+1	22+2
1/2 lb	-	0.5 %	1/2 oz	-	-	4 lb	0+0	-	2+1	18+2
3/4 lb	-	0.75%	3/4 oz	-	-	6 lb	0+0	-	8+4	20+3
1 lb	-	1 %	1 oz	-	-	8 lb	0+0	-	2+2	13+3
1/4 lb	-	0.25%	1/4 oz	4 lb	-	2 lb	0+0	-	2+0	22+3
1/2 lb	-	0.5 %	1/2 oz	8 lb	-	4 lb	0+0	-	3+2	9+4
3/4 lb	-	0.75%	3/4 oz	12 lb	-	6 lb	0+0	-	6+3	7+2
1 lb	-	1 %	1 oz	16 lb	-	8 lb	0+0	-	0+0	-
1/4 lb	-	0.25%	1/4 oz	-	2 lb	2 lb	0+0	-	2+2	20+2
1/2 lb	-	0.5 %	1/2 oz	-	4 lb	4 lb	0+0	-	1+1	20+2
3/4 lb	-	0.75%	3/4 oz	-	6 lb	6 lb	0+0	-	0+1	19+2
1 lb	-	1 %	1 oz	-	8 lb	8 lb	0+0	-	0+1	12+1
1/4 lb	-	0.25%	1/4 oz	-	4 lb	2 lb	0+0	-	2+1	23+1
1/2 lb	-	0.5 %	1/2 oz	-	8 lb	4 lb	0+0	-	4+2	23+3
3/4 lb	-	0.75%	3/4 oz	-	12 lb	6 lb	0+0	-	2+1	15+2
1 lb	-	1 %	1 oz	-	16 lb	8 lb	0+0	-	2+1	9+2
1/4 lb	-	0.25%	1/4 oz	-	-	2 lb	0+0	-	-	-
1/2 lb	-	0.5 %	1/2 oz	-	-	4 lb	0+0	-	-	-
3/4 lb	-	0.75%	3/4 oz	-	-	6 lb	0+0	-	-	-
1 lb	-	1 %	1 oz	-	-	8 lb	0+0	-	-	-
-	4 oz	0.25%	1/4 oz	-	-	2 lb	0+1	(22)	3+1	18+2
-	8 oz	0.5 %	1/2 oz	-	-	4 lb	0+0	-	2+0	22+2
-	12 oz	0.75%	3/4 oz	-	-	6 lb	0+0	-	4+2	26+2
-	16 oz	1 %	1 oz	-	-	8 lb	0+0	-	0+0	-
-	4 oz	0.25%	1/4 oz	4 lb	-	2 lb	0+0	-	3+1	20+2
-	8 oz	0.5 %	1/2 oz	8 lb	-	4 lb	0+0	-	8+2	22+2
-	12 oz	0.75%	3/4 oz	12 lb	-	6 lb	0+0	-	1+1	12+1
-	16 oz	1 %	1 oz	16 lb	-	8 lb	0+0	-	0+0	-
-	4 oz	0.25%	1/4 oz	-	2 lb	2 lb	0+2	(27)	3+1	20+4
-	8 oz	0.5 %	1/2 oz	-	4 lb	4 lb	0+0	-	6+3	20+2
-	12 oz	0.75%	3/4 oz	-	6 lb	6 lb	0+0	-	15+1	17+2
-	16 oz	1 %	1 oz	-	8 lb	8 lb	0+0	-	0+1	12+1
-	4 oz	0.25%	1/4 oz	-	4 lb	2 lb	0+0	-	3+1	18+2
-	8 oz	0.5 %	1/2 oz	-	8 lb	4 lb	0+0	-	2+2	22+2
-	12 oz	0.75%	3/4 oz	-	12 lb	6 lb	0+0	-	2+1	17+3
-	16 oz	1 %	1 oz	-	16 lb	8 lb	0+0	-	0+0	-

* Amounts are in lb per acre or oz per acre of active ingredient except for X-77 surfactant which is percentage, by volume of the total spray mixture.

**Grass heights are in inches.

Table 22. Varying rates of Manage in combination with Telar, 2,4-D amine and X-77 Surfactant on seedhead suppression in fescue and bluegrass. Applied on May 4, 1987. Evaluation on June 28, 1987. IN 126 test area.

Manage	Amount*			Seedheads**			
	X-77	Telar	2,4-D	Fescue		Bluegrass ***	
				Per ft ²	Height	Per ft ²	Height
-	-	-	-	16+2	42+3	6+0	26+2
2 oz	0.25%	-	-	8+2	36+2	8+4	20+1
4 oz	0.5 %	-	-	3+1	29+4	4+2	15+2
6 oz	0.75%	-	-	4+2	22+3	4+1	14+2
2 oz	0.25%	1/4 oz	-	2+2	27+4	4+2	17+2
4 oz	0.5 %	1/2 oz	-	2+2	20+3	4+2	18+1
6 oz	0.75%	3/4 oz	-	2+2	21+3	4+3	12+4
4 oz	0.25%	-	-	4+1	25+3	4+0	17+2
8 oz	0.5 %	-	-	0+1	(21)	3+2	15+3
12 oz	0.75%	-	-	0+0	-	5+3	15+2 Toxic
4 oz	0.25%	1/4 oz	-	1+1	24+4	4+1	16+2
8 oz	0.5 %	1/2 oz	-	1+1	20+2	4+1	15+2 Toxic
12 oz	0.75%	3/4 oz	-	0+0	-	4+2	14+2 Toxic
4 oz	0.25%	1/4 oz	2 lb	1+1	27+0	4+1	16+1
8 oz	0.5 %	1/2 oz	4 lb	1+1	19+2	4+2	14+2 Toxic
12 oz	0.75%	3/4 oz	6 lb	0+0	-	4+2	12+2 Toxic
6 oz	0.25%	-	-	2+1	25+3	4+1	18+2
12 oz	0.5 %	-	-	0+1	18+2	3+2	16+2 Toxic
18 oz	0.75%	-	-	0+0	(20)	4+2	14+2 Toxic
6 oz	0.25%	1/4 oz	-	1+1	23+3	4+0	17+1 Toxic
12 oz	0.5 %	1/2 oz	-	0+0	-	4+2	12+2 Toxic
18 oz	0.75%	3/4 oz	-	0+0	-	4+1	12+1 Toxic

* Rates are in oz or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

** Seedhead heights are in inches averaged from three replications of 3' X 6' plots + standard deviation.

*** Bluegrass seedheads at the time of application were 4/ft² with an average height of 12-14 inches.

Table 23. Embark plus Telar, 2,4-D and X-77 Surfactant in combination with Balan and Poast with or without crop oil on seedhead formation in fescue, bluegrass and orchardgrass. IN-126 test area. Sprayed May 5, 1987. Evaluation on June 17, 1987.

SEEDHEADS**

Amount*				Fescue		Bluegrass		Orchardgrass		Smooth Brome		
Embark	X-77	Telar	2,4-D	Balan	Poast	Crop Oil	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	-	13+1	47+1	3+1	25+0	5	36
1/4 lb 0.25%	1/4 oz	2 lb	-	-	-	-	1+1	21+4	1+0	13+3	1	15
1/4 lb 0.25%	1/4 oz	2 lb	2 lb	-	-	-	0+0	-	0+1	(11)	4	36
1/4 lb 0.25%	1/4 oz	2 lb	4 lb	-	-	-	0+0	(19)	0+1	(7)		
1/4 lb 0.25%	1/4 oz	2 lb	6 lb	-	-	-	0+0	-	1+1	12+5	3	22
1/4 lb 0.25%	1/4 oz	2 lb	-	0.75 lb	-	-	0+0	-	1+1	9+2	3	21
1/4 lb 0.25%	1/4 oz	2 lb	-	0.75 lb	1 qt	0+0	0+0	-	1+1	15+2	2	27
1/4 lb 0.25%	1/4 oz	2 lb	-	-	1 qt	0+0	0+0	-	2+2	13+1		

* Rates are oz per acre or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture and crop oil which is quarts per acre.

** Seedhead heights are in inches ± standard deviations from three replicates.

*** Approximately 90% control of seedheads of smooth brome. Species present only in replication 11.

Table 24. Manage (4 oz/A) in combination with 2,4-D amine, X-77 surfactant and varying rates of Telar on seedhead suppression in fescue and bluegrass. Applied on May 6, 1987. IN 126 test area. Evaluation on June 28, 1987. Seedhead heights at time of application were fescue 15" (1/ft²), bluegrass 16 inches (5/ft²) and orchardgrass, 18 inches (11/ft²).

Manage	Seedheads**			Fescue		Bluegrass	
	Amount*		2,4-D	Per ft ²	Height	Per ft ²	Height
	X-77	Telar					
-	-	-	-	14+2	45+2	5+1	26+2
4 oz	0.25%	-	2 lb	9+5	35+10	4+1	18+3
4 oz	0.25%	1/32 oz	2 lb	9+5	32+3	5+1	18+3
4 oz	0.25%	1/16 oz	2 lb	4+2***	28+6	4+2	21+5
4 oz	0.25%	3/32 oz	2 lb	6+3***	25+4	5+1	16+1
4 oz	0.25%	1/8 oz	2 lb	4+2	23+5	3+0	16+2
4 oz	0.25%	5/32 oz	2 lb	3+2	26+2	5+1	16+2
4 oz	0.25%	3/16 oz	2 lb	3+1	27+5	5+3	17+1

* Rates are in oz or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

** Seedhead heights are in inches averaged from three replications of 3' X 6' plots ± standard deviation.

*** Maximum additive effect of the Telar was achieved at between 1/16 and 3/32 oz per acre with the 4 oz per acre rate of Manage.

Table 25. Embark or Manage with or without Telar in combination with Verdict, Garlon and 2,4-D on seedhead formation in fescue. IN-126 test area. Application was on May 7, 1987. Evaluations were on July 1, 1987. Initial heights of blue grass 19 inches, 6 seedheads/ft²; fescue 18 inches.

Embark	Manage	Amount*					Seedheads**			
		X-77	Telar	Verdict	Garlon	2,4-D	Fescue Per ft ²	Height	Bluegrass Per ft ²	Height
-	-	-	-	-	-	-	16+4	44+3	5+1	26+2
1/4 lb	-	0.25%	1/4 oz	-	-	2 lb	2+1	20+3	5+0	17+3
1/4 lb	-	0.25%	-	1/16 lb	-	2 lb	7+2	31+6	7+1	20+4
-	3 oz	0.25%	1/4 oz	-	-	2 lb	8+6	34+12	5+1	18+4
-	3 oz	0.25%	-	1/16 oz	-	2 lb	8+5	34+4	5+0	13+2
-	3 oz	0.25%	1/8 oz	-	-	2 lb	4+3	28+8	6+2	16+4
-	3 oz	0.25%	-	-	-	2 lb	9+6	32+2	7+2	20+2
-	3 oz	0.25%	-	1/32 lb	-	1 lb	6+2	27+1	5+0	15+2
-	3 oz	0.25%	-	1/32 lb	1/2 lb	1 lb	8+3	30+3	5+1	17+2***

* Amounts are in lb/A or oz/A of active material except for X-77 which is amount by volume of the total spray mixture.

**Seedhead heights are measured in inches ± standeard deviations based on six replications.

***Appeared to be a definite antagonism upon the addition of the Garlon. The fescue especially appeared more robust with the Garlon addition to the overall mixture.

Table 26. Different rates of Manage in combination with Telar, Balan, X-77 Surfactant and 2,4-D amine on seedhead suppression of smooth brome. Treatments applied May 8, 1987. Evaluations on May 20, 1987. IN 126 test area. Initial heights: smooth brome 20 inches; fescue, 19 inches; bluegrass, 19 inches, seedheads already forming.

Manage	X-77	Amount per acre*		2,4-D	Amine	Smooth Brome		Fescue		Bluegrass			
		Telar	Balan			Seedheads Per ft ²	Blade Height	Seedheads Per ft ²	Blade Height	Seedheads Per ft ²	Blade Height		
-	-	-	-	-	-	8+2	31+2	19+1	10+2	36+2	18+1	2+2	20+10
6 oz	0.25%	1/4 oz	4 lb	2 lb	8+2	25+3	18+2	3+1	22+2	20+1	3+2	23+2	
12 oz	0.5%	1/2 oz	8 lb	4 lb	9+1	29+2	18+2	4+2	22+2	20+1	1+1	25+2	
18 oz	0.75%	3/4 oz	12 lb	6 lb	9+1	34+2	23+2	9+3	26+1	19+1	3+1	30+3	
24 oz	1%	1 oz	16 lb	8 lb	5+2	26+1	23+2	8+2	32+3	22+2	4+1	26+2	
4 oz	0.25%	1/4 oz	4 lb	2 lb	8+2	31+2	20+1	8+2	27+3	20+1	2+1	22+2	
8 oz	0.5%	1/2 oz	8 lb	4 lb	4+2	22+3	19+1	7+3	29+4	21+2	1+1	20+1	
12 oz	0.75%	3/4 oz	12 lb	6 lb	2+1	29+2	20+2	3+1	28+2	20+2	3+1	20+2	
16 oz	1%	1 oz	16 lb	8 lb	2+2	39+2	22+2	0+0	-	22+1	2+0	26+1	
3 oz	0.25%	1/8 oz	4 lb	2 lb	2+1	27+2	19+2	4+1	22+2	21+1	1+1	19+2	
6 oz	0.5%	1/4 oz	8 lb	4 lb	4+3	27+3	21+2	2+0	26+4	22+2	1+1	22+2	
9 oz	0.75%	3/8 oz	12 lb	6 lb	1+1	34+4	21+2	3+2	21+2	20+1	1+1	20+1	
12 oz	1%	1/2 oz	16 lb	8 lb	4+2	36+2	23+2	2+1	25+1	22+2	0+1	(23)	
3 oz	0.25%	1/4 oz	4 lb	2 lb	4+3	32+2	19+2	4+2	23+2	21+2	1+1	18+2	
6 oz	0.5%	1/2 oz	8 lb	4 lb	4+1	27+2	19+1	4+1	30+6	19+2	1+1	17+2	
9 oz	0.75%	3/4 oz	12 lb	6 lb	2+1	29+2	19+2	1+1	22+1	19+1	2+2	28+0	
12 oz	1%	1 oz	16 lb	8 lb	5+2	25+2	23+2	1+2	20+2	23+2	2+1	24+2	
2 oz	0.25%	1/4 oz	4 lb	2 lb	6+2	34+4	22+2	3+1	28+1	21+2	1+1	22+2	
4 oz	0.5%	1/2 oz	8 lb	4 lb	5+3	33+6	20+2	3+1	26+6	21+1	1+1	19+1	
6 oz	0.75%	3/4 oz	12 lb	6 lb	3+2	30+3	22+2	2+1	25+3	23+2	2+2	23+1	
8 oz	1%	1 oz	16 lb	8 lb	4+2	30+2	23+2	6+2	25+1	23+1	2+0	24+2	

* Embark = 1b/A of mefluidide; X-77 = percent by volume of the total spray mixture. All other materials are oz/A or 1b/A of active materials.

Grass heights are in inches.

Manage plots, at all rates were discolored (yellow) although not objectionable so.

Table 27. Embark or Manage plus Telar and 2,4-D in the presence of p-nitro-phenylacetate (pNPAC) or 8-hydroxy-5-guinoiline N-oxide (8-OH-5-NQO) on seedhead formation in fescue. Application on May 9, 1987. Evaluation on July 1, 1987. IN-126 test area.

Embark	Manage	Amount*					Seedheads**			
		X-77	Telar	4-PNAC	8-OH-5-NQO	2,4-D	Fescue		Bluegrass	
							Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	-	14+2	40+6	6+2	25+3
1/4 lb	-	0.25%	1/4 oz	1 lb	-	2 lb	12+2	27+4	6+4	17+3
-	3 oz	0.25%	1/4 oz	1 lb	-	2 lb	10+2	22+1	4+1	22+1
1/4 lb	-	0.25%	1/4 oz	-	1 lb	2 lb	10+2	21+4	6+2	19+4
-	3 oz	0.25%	1/4 oz	-	1 lb	2 lb	12+2	26+7	6+2	22+2
-	4 oz	0.25%	1/4 oz	-	-	2 lb	13+1	25+1	6+2	21+4
-	4 oz	0.25%	1/8 oz	-	-	2 lb	13+3	34+14	4+1	22+4
-	3 oz	0.25%	1/4 oz	-	-	2 lb	13+3	27+6	4+1	20+2
-	3 oz	0.25%	1/8 oz	-	-	2 lb	13+3	40+2	5+1	26+2

* Amounts are in oz/acre or lb per acre of the active material except for the X-77 surfactant which is percent by volume of the total spray mixture.

**Seedheads are given in inches ± standard deviations from three replications.

Table 28. Rate of Manage in combination with Verdict, X-77 Surfactant, Garlon and 2,4-D on seedhead formation in fescue. Applications were on May 11, 1987. Evaluations were on July 1, 1987. IN-126 test area. Grass heights at the time of application: bluegrass 16-26 inches, 6-18 seedheads/ft²; fescue 17 inches, 3 seedheads per ft². Heavy rain about midnight the night following application in early evening.

Manage					Seedheads**			
	X-77	Amount*	Garlon	2,4-D	Fescue		Bluegrass	
		Verdict			Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	16+0	49+2	5+1	27+2
2 oz	0.25%	1/32 lb	1/2 lb	1 lb	18+2	44+2	5+1	25+2
4 oz	0.5%	1/16 lb	1 lb	2 lb	12+3	39+4	4+2	25+2
8 oz	1%	1/8 lb	2 lb	4 lb	13+2	40+3	4+2	22+2
3 oz	0.25%	1/32 lb	1/2 lb	1 lb	19+1	46+2	5+1	27+2
6 oz	0.5%	1/16 lb	1 lb	2 lb	14+4	42+6	6+2	24+2
12 oz	1%	1/8 lb	2 lb	4 lb	12+3	41+3	5+3	19+2
4 oz	0.25%	1/32 lb	1/2 lb	1 lb	15+3	46+2	4+1	26+2
8 oz	0.5%	1/16 lb	1 lb	2 lb	12+4	38+2	5+2	21+3
16 oz	1%	1/8 lb	2 lb	4 lb	10+1	33+4	4+1	17+1
6 oz	0.25%	1/32 lb	1/2 lb	1 lb	16+2	45+2	4+1	26+1
12 oz	0.5%	1/16 lb	1 lb	2 lb	12+3	38+4	5+3	19+3
24 oz	1%	1/8 lb	2 lb	4 lb	14+3	44+4	5+2	20+3

* Amounts are in lb/A or oz/A of active material except for X-77 surfactant which is percent by volume of the total spray mixture.

**Seedhead heights are in inches ± standard deviations from three replications.

Table 29. Embark or Manage in combination with Telar or Oust on seedhead suppression of fescue and bluegrass. IN-126 test area. Applied on May 13, 1987. Evaluation on June 2, 1987. Initial heights: fescue, 15-22 inches and 4 seedheads/ft²; bluegrass 11-13 inches and 4 seedheads/ft²; fescue blade height 14 inches.

Embark	Manage	Amount*		Oust	2,4-D	Seedheads**			
		X-77	Telar			Fescue		Bluegrass	
						Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	11+1	34+2	1+1	15+1
1/4 lb	-	0.25%	1/4 oz	-	2 lb	6+1	20+1	1+0	13+1
1/2 lb	-	0.5 %	1/2 oz	-	4 lb	5+1	22+1	2+1	16+0
1 lb	-	1 %	1 oz	-	8 lb	5+1	21+1	1+2	15+1
1/4 lb	-	0.25%	-	1/8 oz	2 lb	4+1	19+1	1+1	13+1
1/2 lb	-	0.5 %	-	1/4 oz	4 lb	8+2	26+2	1+0	12+3
1 lb	-	1 %	-	1/2 oz	8 lb	6+1	25+1	1+1	12+1
-	6 oz	0.25%	1/4 oz	-	2 lb	5+3	17+2	1+1	12+1
-	12 oz	0.5 %	1/2 oz	-	4 lb	4+2	19+3	0+1	11+2
-	24 oz	1 %	1 oz	-	8 lb	4+2	19+1	1+1	11+2
-	6 oz	0.25%	-	1/8 oz	2 lb	4+0	16+3	1+0	11+0
-	12 oz	0.5 %	-	1/4 oz	4 lb	4+1	18+1	0+1	(11)
-	24 oz	1 %	-	1/2 oz	8 lb	4+1	17+2	1+1	11+2

* Rates are in lb/A or oz/A of active ingredient except for surfactant X-77 which is percentage by volume of the total spray mixture.

** Seedhead heights are in inches.

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Table 30. Manage, 4 oz/A plus X-77 surfactant and 2,4-D amine (2 lb/A) in combination with varying rates of Oust on seedhead formation in fescue. IN-126 test area. Application on May 12. Evaluation on June 5, 1987. Initial heights: fescue 13 in, no seedheads; bluegrass 25 inches, 2 seedheads/ft².

Manage	Amount*			Fescue			Bluegrass		
	X-77	2,4-D	Oust	Seedheads Per ft ²	Blade Height	Blade Height**	Seedheads Per ft ²	Blade Height	Blade Height**
-	-	-	-	11 _± 1	35 _± 1	15 _± 2	3 _± 1	21 _± 3	14 _± 1
4 oz	0.25 _± 0%	2 lb	-	3 _± 1	23 _± 1	14 _± 1	2 _± 1	15 _± 2	12 _± 2
4 oz	0.25 _± 0%	2 lb	1/32 oz	3 _± 1	18 _± 2	14 _± 3	2 _± 2	13 _± 2	11 _± 1
4 oz	0.25 _± 0%	2 lb	1/16 oz	3 _± 1	18 _± 2	14 _± 1	2 _± 1	13 _± 1	13 _± 1
4 oz	0.25 _± 0%	2 lb	3/32 oz	3 _± 1	17 _± 2	12 _± 2	2 _± 1	11 _± 1	9 _± 2
4 oz	0.25 _± 0%	2 lb	1/8 oz	2 _± 1	16 _± 2	13 _± 2	1 _± 1	13 _± 5	9 _± 2
4 oz	0.25 _± 0%	2 lb	5/32 oz	1 _± 1	17 _± 2	12 _± 1	1 _± 1	11 _± 1	9 _± 1
4 oz	0.25 _± 0%	2 lb	3/16 oz	2 _± 1	17 _± 1	13 _± 1	1 _± 1	11 _± 2	10 _± 1

* Amounts are lb/acre or oz/acre of active ingredient except for X-77 which is percent by volume of the total spray mixture (40 gpa).

** Grass heights are in inches.

Table 31. Late applications of Embark or Manage in combination with Telar or Oust and X-77 Surfactant and 2,4-D on seedhead formation in fescue. IN-126 test area. Plots will be resprayed in 1988 as a residual environmental test. Treatments with Embark were applied on May 7, 1987. Treatments with Manage were applied on May 12, 1987. Evaluations were on July 15, 1987. Grass heights at the time of spraying were bluegrass, blade height 15 in, seedhead height 21 in, 4-5 seedheads/ft²; fescue seedhead height was 23+1 in, blade height 21 inches, 10+2 seedheads/ft² on May 12 and no seedheads on May 7.

Embark	Manage	Amount*				Fescue Seedheads**		Notes
		X-77	Telar	Oust	2,4-D	Per ft ²	Height	
-	-	-	-	-	-	17 ± 1	42 ± 4	
1/4 lb	-	0.25%	1/4 oz	-	2 lb	0 ± 0	-	Appearance good
1/8 lb	-	0.25%	1/8 oz	-	2 lb	5 ± 1	23 ± 1	"
1/4 lb	-	0.5 %	-	-	-	0 ± 1	22 ± 4	"
-	3 oz	0.25%	1/8 oz	-	2 lb	9 ± 3	30 ± 1	
-	6 oz	0.25%	1/4 oz	-	2 lb	10 ± 1	28 ± 1	
-	3 oz	0.25%	-	1/16 oz	2 lb	9 ± 3	29 ± 1	
-	6 oz	0.25%	-	1/8 oz	2 lb	6 ± 2	29 ± 1	Toxic to bluegrass

* Rates are in amounts per acre except for X-77 surfactant which is percent by volume of the total spray mixture. Amounts are active ingredient.

** Grass height measured in inches ± standard deviations.

Table 32. Late application of Embark plus Telar or Manage plus Telar in combination with surfactant X-77 and 2,4-D amine plus EL-107 on seedhead formation in fescue. Application on May 11, 1987. Evaluation on June 5, 1987. Initial seedheads: fescue 18-23 in, 10-12/ft²; bluegrass 22 in, 12/ft². IN-126 test area. Heavy rain following application about midnight.

Embark	Amount*		Telar	EL-107	2,4-D	Fescue		Seedheads**		Orchardgrass	
	Manage	X-77				Per ft ²	Height	Bluegrass		Per ft ²	Ht
-	-	-	-	-	-	13+1	28+2	7+4	26+3	3	36
1/4 lb	-	0.25%	1/4 oz	1 lb	2 lb	9+3	27+4	7+1	21+2	2	30
1/4 lb	-	0.25%	1/4 oz	2 lb	2 lb	11+3	23+3	6+2	21+1	4	33
-	3 oz	0.25%	1/4 oz	1 lb	2 lb	11+1	28+4	6+2	24+1	4	33
-	3 oz	0.25%	1/4 oz	2 lb	2 lb	13+2	29+5	6+1	24+1		

* Pounds per acre or ounces per acre of active ingredient except for X-77 surfactant which was percentage by volume of the total spray mixture.

** Grass height in inches.

Table 33. Embark plus Telar or Manage plus Telar in combination with X-77 surfactant and 2,4-D amine and Poast with or without Crop Oil on seedhead formation in smooth brome, fescue and quackgrass. IN-126 test area. Application on May 13, 1987. Evaluation on June 5, 1987. Initial grass heights: fescue 25 inches, 12 seedheads/ft²; smooth brome 23 inches, no seedheads; blue grass 23 inches, 16 seedheads/ft²; quackgrass, no seedheads.

Embark	Manage	X-77	Amount*			Crop Oil	Fescue		Bluegrass		Smooth Brome		Quackgrass	
			Glean	Poast	2,4-D		Per ft ²	Height	Per ft ²	Height	Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	-	-	10+2	36+2	9+3	31+3	14+2	44+4	11+1	32+5
1/4 lb	-	0.25%	1/4 oz 0.3 lb	-	2 lb	12+0	37+1	12+3	27+2	7+1	35+3	0+0	(22)***	
1/2 lb	-	0.5%	1/2 oz 0.6 lb	-	4 lb	8+4	18+4	12+2	20+2	Not toxic to bluegrass				
1 lb	-	1%	1 oz 1.2 lb	-	8 lb			10+3	16+2					
1/4 lb	-	0.25%	1/4 oz 0.3 lb	1 qt	2 lb	11+1	23+3	7+1	25+1	3+1	24+4	0+0	(21)	
1/2 lb	-	0.5%	1/2 oz 0.6 lb	2 qt	4 lb	10+2	22+2	12+2	18+2	Not toxic to bluegrass				
1 lb	-	1%	1 oz 1.2 lb	4 qt	8 lb	12+2	20+2	10+3	13+2					
-	4 oz	0.25%	1/4 oz 0.3 lb	-	2 lb	12+0	23+7	6+2	27+1	5+1	25+1	0+0	(22)	
-	8 oz	0.5%	1/2 oz 0.6 lb	-	4 lb	12+0	23+2	12+3	16+2	Not toxic to bluegrass				
-	16 oz	1%	1 oz 1.2 lb	-	8 lb			8+3	13+2					
-	4 oz	0.25%	1/4 oz 0.3 lb	1 qt	2 lb	12+0	22+2	4+1	23+3	11+1	20+2**	0+0	(21)	
-	8 oz	0.5%	1/2 oz 0.6 lb	2 qt	4 lb			12+3	18+2					
-	16 oz	1%	1 oz 0.6 lb	4 qt	8 lb			8+3	15+2	Not toxic to bluegrass				

* Amounts are lb/acre or oz/acre of active material except for X-77 surfactant which is percent by volume of the total spray mixture (40 gpa) and crop oil which is quarts per acre.

** Grass height is in inches

*** Blade height in inches

** Grass very short including seedheads. A very effective treatment applied late.

Table 34. Effect of a fall application of Embark with and without Poast and crop oil on fescue and bluegrass viability. Applications were on September 26, 1986. Evaluations on June 16, 1987. IN-126 test area.

Amount*						Grass Clumps per 20 ft ²	
<u>Embark</u>	<u>X-77</u>	<u>Telar</u>	<u>Poast</u>	<u>Crop Oil</u>	<u>2,4-D</u>	<u>Bluegrass</u>	<u>Fescue</u>
-	-	-	-	-	-	11+3	13+2
1/4 lb	0.25%	1/4 oz	-	-	2 lb	10+2	9+3
1/4 lb	0.25%	-	1/2 lb	-	2 lb	3+1	6+3
1/4 lb	0.25%	-	1 lb	-	2 lb	4+2	3+3
1/4 lb	0.25%	-	1/2 lb	1 qt	2 lb	5+2	6+1
1/4 lb	0.25%	-	1 lb	1 qt	2 lb	8+1	3+2
1/4 lb	0.25%	-	-	1 qt	2 lb	10+1	10+1
1/4 lb	0.25%	-	-	2 qt	2 lb	10+2	9+3

* Amount is oz or lb per acre of active ingredient except for X-77 surfactant which is percent by volume of the total spray mixture.

Table 35. Mon 4625 and Mon 4629 in combination with Telar and 2,4-D on seedhead formation in fescue. IN-126 test area. Sprayed May 14, 1987. Evaluation on June 6, 1987. Initial grass heights: fescue seedhead height 18-22 in, blade height 18 in, 8 seedheads/ft²; bluegrass seedhead height 26 in, blade height 12-14 in, 4-8 seedheads/ft².

Mon 4625	Amount*				Seedheads**			
	Mon 4529	X-77	Telar	2,4-D	Fescue Per ft ²	Height	Bluegrass Per ft ²	Height
-	-	-	-	-	12+0	38+0	3+0	27+2
1 lb	-	0.25%	-	-	13+1	38+2	4+1	26+2
2 lb	-	0.5 %	-	-	12+1	26+2	3+1	20+1
4 lb	-	1 %	-	-	11+1	32+2	3+1	22+2
1 lb	-	0.25%	1/4 oz	-	12+0	27+4	3+1	22+3
2 lb	-	0.5 %	1/2 oz	-	12+2	27+2	3+2	22+2
4 lb	-	1 %	1 oz	-	10+2	25+1	2+1	18+2
1 lb	-	0.25%	1/4 oz	2 lb	12+0	27+3	4+1	21+3
2 lb	-	0.5 %	1/2 oz	4 lb	12+2	24+2	3+1	22+2
4 lb	-	1 %	1 oz	8 lb	12+2	26+2	3+1	24+2
-	1 lb	0.25%	-	-	12+0	34+3	3+2	22+1
-	2 lb	0.5 %	-	-	12+0	36+4	2+2	23+2
-	4 lb	1 %	-	-	12+1	32+4	3+1	22+2
-	1 lb	0.25%	1/4 oz	-	11+1	27+4	3+1	26+2
-	2 lb	0.5 %	1/2 oz	-	12+1	28+2	3+1	15+2
-	4 lb	1 %	1 oz	-	12+1	22+2	3+1	20+1
-	1 lb	0.25%	1/4 oz	2 lb	12+0	32+2	3+1	22+2
-	2 lb	0.5 %	1/2 oz	4 lb	11+2	32+2	3+2	21+2
-	4 lb	1 %	1 oz	8 lb	12+1	25+2	2+1	22+2

* Rates are in pounds or ounces of active material per acre except for X-77 surfactant which is percent by volume of the total spray mixture.

** Grass heights are in inches.

Table 36. Manage in combination with Verdict, Garlon and 2,4-D on seedhead formation in fescue. 1N-126 test area. Applications on May 15, 1987. Evaluation on June 6, 1987. Initial grass heights: fescue 24-27 inches, 4-12 seedheads/ft²; bluegrass 26-28 in, 2-4 seedheads/ft².

Manage	X-77	Amount*			Seedheads**			
		Verdict	Garlon	2,4-D	Fescue		Bluegrass	
					Per ft ²	Height	Per ft ²	Height
-	-	-	-	-	13+1	36+0	3+1	28+2
6 oz	0.25%	1/32 lb	1/2 lb	1 lb	12+0	21+2	2+1	18+3
12 oz	0.5 %	1/16 lb	1 lb	2 lb	12+1	26+2	2+1	20+2
24 oz	1 %	1/8 lb	2 lb	4 lb	12+0	25+2	4+1	21+3
4 oz	0.25%	1/32 lb	1/2 lb	1 lb	12+0	23+3	4+1	20+1
8 oz	0.5 %	1/16 lb	1 lb	2 lb	12+2	30+2	3+1	25+2
16 oz	1 %	1/8 lb	2 lb	4 lb	13+1	23+1	3+1	19+2
3 oz	0.25%	1/32 lb	1/2 lb	1 lb	12+0	29+2	4+1	24+2
6 oz	0.5 %	1/16 lb	1 lb	2 lb	12+1	23+2	3+1	22+2
12 oz	1 %	1/8 lb	2 lb	4 lb	12+1	25+2	4+1	23+1
2 oz	0.25%	1/32 lb	1/2 lb	1 lb	11+1	31+5	6+2	22+1
4 oz	0.5 %	1/16 lb	1 lb	2 lb	10+2	26+2	2+1	24+1
8 oz	1 %	1/8 lb	2 lb	4 lb	12+1	23+2	3+1	20+2

Toxic

* Amounts are pounds or ounces per acre of active materials except for X-77 surfactant which is percent by volume of the total spray mixture.

**Seedhead heights are in inches.

Table 37. ACP 1900 in combination with Embark or Manage, X-77 Surfactant and 2,4-D with or without Telar on seedhead formation in fescue. IN-126 test area. Application on Friday May 15, 1987. Evaluations on June 6, 1987. Initial fescue height 26 inches, 15 seedheads/ft². Initial bluegrass height 26-28 inches, 2-4 seedheads/ft².

Embark	Manage	Amount*		ACP-1900	2,4-D	Seedheads**			
		X-77	Telar			Fescue Per ft ²	Fescue Height	Bluegrass Per ft ²	Bluegrass Height
-	-	-	-	-	-	12+0	38+0	2+0	21+3
1/4 lb	-	0.25%	1/4 oz	-	2 lb	10+4	22+2	3+1	19+2
1/2 lb	-	0.5 %	1/2 oz	-	4 lb	13+1	25+2	4+1	21+2
1 lb	-	1 %	1 oz	-	8 lb	12+2	28+3	4+1	20+1
1/4 lb	-	0.25%	-	1/8 oz	2 lb	12+1	27+7	2+1	16+4
1/2 lb	-	0.5 %	-	1/4 oz	4 lb	14+2	25+2	1+1	16+2
1 lb	-	1 %	-	1/2 oz	8 lb	11+1	21+2	4+2	19+1
-	-	0.25%	-	1/4 oz	2 lb	12+0	31+4	3+1	24+3
-	-	0.5 %	-	1/2 oz	4 lb	11+2	26+2	4+2	19+2
-	-	1 %	-	1 oz	8 lb	12+2	28+2	5+3	25+2
-	-	0.25%	1/4 oz	1/8 oz	2 lb	12+1	25+2	3+1	19+4
-	-	0.5 %	1/2 oz	1/4 oz	4 lb	10+2	27+2	2+1	21+2
-	-	1 %	1 oz	1/2 oz	8 lb	12+2	25+2	3+2	19+2
-	4 oz	0.25%	-	-	2 lb	12+0	28+4	4+2	21+2
-	8 oz	0.5 %	-	-	4 lb	11+1	23+2	4+1	18+2
-	16 oz	1 %	-	-	8 lb	10+2	23+1	3+2	20+1
-	4 oz	0.25%	1/4 oz	-	2 lb	11+1	23+3	1+0	18+2
-	8 oz	0.5 %	1/2 oz	-	4 lb	12+1	27+2	2+1	16+2
-	16 oz	1 %	1 oz	-	8 lb	13+1	27+2	4+1	19+2
-	4 oz	0.25%	-	1/8 oz	2 lb	11+1	25+1	4+0	18+2
-	8 oz	0.5 %	-	1/4 oz	4 lb	12+2	27+2	2+1	22+1
-	16 oz	1 %	-	1/2 oz	8 lb	14+2	29+2	3+2	23+2

* Amounts are oz per acre or lb per acre except for X-77 surfactant which is percent by volume of the total spray mixture.

** Grass heights are in inches.

Plant Growth Retardant Plots on US 136

A total of 10 plots were designated and material applied to 1 thru 7 on 4-27-87. There was a gusty south wind on that day, which caused some problems in obtaining a full width spray pattern.

The plots start approximately 3.5 miles east of Mace and continue east to Lizton. All plots are on the south side of the pavement.

Plots 8 thru 10 were sprayed on 5-1-87. The wind was light from the east.

- | | |
|----------|---|
| Plot #1 | Surflan A.S. - 2 qts/A. (Foxtail control) |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #2 | Treflan - 2 qts/A. (Foxtail control) |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #3 | Embark - 1 pt., Garlon-4 - 2 qts., Verdict - 2 oz., 2,4-D - 2 qt. per acre. |
| | Length = 1 mile Area = 2 acre |
| Plot #4 | Manage - 6 oz., 2,4-D - 2 qts., Telar - $\frac{1}{2}$ oz. per acre. |
| | Length = 1 mile Area = 2 acre |
| Plot #5 | Embark - 1 pt., Garlon-4 - 1 gal. |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #6 | Embark - 1 pt., Starane - $1\frac{1}{2}$ qt. |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #7 | Embark - 1 pt., Verdict - 2 oz. |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #8 | Surflan A.S. - 3 qt. (Foxtail control) |
| | Length = $\frac{1}{2}$ mile Area = 1 acre |
| Plot #9 | Embark - 1 pt., Poast - 1 qt., Crop Oil - 1 qt., 2,4-D - 2 qt. per acre. |
| | Length = 1 mile Area = 2 acre |
| Plot #10 | Embark - 1 pt., Verdict - 2 oz., Garlon-4 - 2 qt. |
| | Length = 1 mile Area = 1 acre |

All plots are marked at the beginning and end with the attached sign. The 1 mile plots are also marked with a sign at the midway point.

Table 38. Evaluation of growth retardant combinations on formation of seedheads in fescue, bluegrass, smooth brome, orchardgrass and timothy. US 136 test area. Swinglok equipment. Applied by Don Bickie and crew, Crawfordsville. Plots 3-7 were applied on April 27, 1987*. Plots 8-10 were sprayed on May 1, 1987. Evaluations on June 15, 1987. Plots were 0.5 to 1 mile long.

Amount**										Seedheads****									
**** Surft- Fescue										Bluegrass Smooth Brome Orchardgrass Timothy									
No	Embark	Manage 2,4-D	Verdict	Telar	Ga'lon	Starane	Poa	lan	Per ft ²	Ht	Per ft ²	Ht	Per ft ²	Ht	Per ft ²	Ht	Per ft ²	Ht	
0	-	-	-	-	-	-	-	-	14+2	41+3	4+1	27+3	12+4	40+2	5+2	42+4	4	40	
3	1 pt	-	2 qt	2 oz	-	2 qt	-	-	8+0	27+3	9+3	11+1	3+1	23+2	7+3	24+2	1	14	
4	-	6 oz	2 qt	-	1/2 oz	-	-	-	8+2	27+3	0+0	-	Tox	5+3	18+4	5+2	24+2	4	
5	1 pt	-	-	-	1 gal	-	-	-	3+1	22+4	1+1	16+1			4+1	24+2			
6	1 pt	-	-	-	-	1 1/2 qt	-	-	2+1	19+4	2+2	13+2	Tox	7+1	32+0	3+3	29+5		
7	1 pt	-	-	2 oz	-	-	-	-	5+2	32+6	0+1	(12)	9+3	29+2	7+4	14+4			
8	-	-	-	-	-	-	-	3 qt	11+1	36+3	9+1	22+1							
9	1 pt	-	-	-	-	-	1 qt	****	3+1	32+1	4+0	19+0	9+3	38+2	3+1	32+2	Tox		
10	1 pt	-	-	2 oz	-	2 qt	-	-	6+2	25+5	8+5	18+3	1+1	26+2	2+1	24+4	2	21	

* Plot 1 was Surflan 2 qt/A and Plot 2 was Treflan 2 qt/A for foxtail control and were without effect on seedheads.

** Amount are in rates of actual material per acre. Surfactant (0.25% by volume of total spray mixture) X-77 was included.

*** Seedheads per square foot and seedhead height in inches ± standard deviation from 3 different locations within each plot.

**** Contained 1 quart per acre of crop oil.

Tox - Toxic to the grass species indicated.

Table 39. Comparison of Manage + Telar and a low rate of Embark + Telar. 1-74 east of Crawfordsville Interchange.

A. Application by contractor. Applied 3rd week of April.

Manage 4 oz/A; Telar 1/4 oz/A; 2,4-D 1/2 gal (2 lb)/A. No surfactant.

<u>Location</u>	<u>Treatment</u>	Fescue		Bluegrass		Smooth Brome		SEEDHEADS* Orchardgrass		Timothy		<u>Notes</u>
		<u>Per ft²</u>	<u>Height</u>	<u>Per ft²</u>	<u>Height</u>	<u>Per ft²</u>	<u>Height</u>	<u>Per ft²</u>	<u>Height</u>	<u>Per ft²</u>	<u>Height</u>	
Median	Control	12+2	36+0	3+1	20+1	12+2	35+2	3+1	21+1	4+2	38+2	
	Treated	6+1	26+2	3+1	12+1	3+2	26+3	1	11	2+2	19+1	
Pavement to Ditch	Control	13+1	49+3	3+1	24+3	12+1	38+3	3	30	7+1	37+0	
	Treated	8+3	29+4	1+0	11+0	6+4	28+4	4	26			Toxic to bluegrass

B. Application by Don Bickle and crew; Swinglok equipment. Applied about May 1, 1987.

Embark 1/2 pt (1/8 lb); Telar 1/8 oz; 2,4-D 1/2 gal (2 lb) per acre. Contained 0.25% by volume of the total spray mixture of X-77 surfactant.

Pavement to Ditch	Control	13+1	39+3	3+1	21+1	13+1	37+3	5+1	40+5	4+2	38+2	
	Treated	6+3	26+2	2+1	15+2	10+2	26+1	1	22	4+2	26+1	

Table 40 . Comparison of Telar and Verdict additives in combination with Embark and 2,4-D as affected by the addition of Garlon-4 on fall growth of bluegrass comparing three different locations.

						Growth, inches			
Amount*						Application Date 1987			
Embark	X-77	Telar	Verdict	Garlon-4	2,4-D	Sept 3	Sept 5	Sept 14	Ave
-	-	-	-	-	-	2.5 \pm 0.0	2.5 \pm 0.0	2.0 \pm 0.0	2.3 \pm 0.3
1/4 lb	0.25%	1/4 oz	-	-	2 lb	0.9 \pm 0.3	0.7 \pm 0.3	0.6 \pm 0.1	0.7 \pm 0.2
1/4 lb	0.25%	-	1/16 lb	-	2 lb	1.5 \pm 0.0	1.3 \pm 0.3	1.1 \pm 0.2	1.3 \pm 0.3
1/4 lb	0.25%	-	-	1/2 lb	2 lb	1.5 \pm 0.0	1.7 \pm 0.3	1.2 \pm 0.2	1.5 \pm 0.2
1/4 lb	0.25%	1/4 oz	-	1/2 lb	2 lb	0.9 \pm 0.3	0.8 \pm 0.3	0.8 \pm 0.2	0.8 \pm 0.1
1/4 lb	0.25%	-	1/16 lb	1/2 lb	2 lb	2.0 \pm 0.3	1.8 \pm 0.3	2.0 \pm 0.0	1.9 \pm 0.1

*Amount is active material per acre except for X-77 which is percent by volume of the total spray mixture.

Grass was mowed to a uniform height of 2 inches prior to application of treatment. Growth was measured in inches \pm standard deviations approximately two weeks after treatment.

Table 41. Effect of Garlon-4 at 1/2 lb/A on the performance of an Embark plus Telar combination and growth inhibition by experimental materials HONOQ and PNPAC on fall growth of bluegrass. Application was on September 9, 1987.

<u>Embark</u>	<u>X-77</u>	<u>Telar</u>	<u>Amount*</u>				<u>Growth, inches</u>	
			<u>Garlon-4</u>	<u>2,4-D</u>	<u>HONOQ</u>	<u>PNPAC</u>	<u>Sept 15</u>	<u>Sept 23</u>
-	-	-	-	-	-	-	3.3 \pm 0.2	4.5 \pm 0.5
1/4 lb	0.25%	1/4 oz	-	2 lb	-	-	1.0 \pm 0.0	1.5 \pm 0.0
1/4 lb	0.25%	1/4 oz	1/2 lb	2 lb	-	-	1.0 \pm 0.0	1.5 \pm 0.0
Applied in ethanol:								
-	-	-	-	-	-	-	3.2 \pm 0.2	4.0 \pm 0.0
-	-	-	-	-	4 lb	-	2.6 \pm 0.6	3.0 \pm 0.0
-	-	-	-	-	-	4 lb	2.3 \pm 0.6	3.0 \pm 0.0

*Amount is active material per acre except for X-77 which is percent by volume of the total spray mixture. Both HONOQ and PNPAC were applied in ethanol compared to an ethanol control.

Table 42. Combination of Embark + Surfactant + 2,4-D + Verdict. Effect of 2,4-D and Garlon-4 additions. Applications were on September 12, 1987 with evaluations on September 23. Initial grass height was 2-2.5 inches (mowed).

<u>Embark</u>	<u>X-77</u>	<u>Verdict</u>	<u>Garlon</u>	<u>2,4-D</u>	<u>Bluegrass growth, inches</u>
-	-	-	-	-	3.0 \pm 0.5
1/4 1b	0.25%	-	-	-	1.5 \pm 0.0
1/4 1b	0.25%	-	-	2 1b	1.9 \pm 0.2
1/4 1b	0.25%	1/16 1b	-	-	1.6 \pm 0.1
1/4 1b	0.25%	1/16 1b	-	2 1b	1.4 \pm 0.2
1/4 1b	0.25%	1/16 1b	1/2 1b	-	1.4 \pm 0.1
1/4 1b	0.25%	1/16 1b	1/2 1b	2 1b	1.7 \pm 0.0

Table 43. Effect of 2,4-D concentration on fall growth of bluegrass in the combination of Embark + Surfactant + Telar + Garlon-4 and the combination of Embark + Surfactant + Verdict + Garlon-4. Applications were on September 15, 1987 with evaluations on September 26, 1987. Initial grass height was 2.25 inches.

<u>Embark</u>	<u>Amount*</u>					<u>Bluegrass growth, inches</u>
	<u>X-77</u>	<u>Telar</u>	<u>Verdict</u>	<u>Garlon-4</u>	<u>2,4-D</u>	
-	-	-	-	-	-	2.5 \pm 0.3
1/4 1b	0.25%	1/4 oz	-	-	-	0.2 \pm 0.1
1/4 1b	0.25%	1/4 oz	-	1/2 1b	-	0.4 \pm 0.1
1/4 1b	0.25%	1/4 oz	-	1/2 1b	1/2 1b	0.5 \pm 0.2
1/4 1b	0.25%	1/4 oz	-	1/2 1b	1 1b	0.9 \pm 0.1
1/4 1b	0.25%	1/4 oz	-	1/2 1b	2 1b	0.8 \pm 0.4
1/4 1b	0.25%	-	1/16 1b	-	-	0.7 \pm 0.3
1/4 1b	0.25%	-	1/16 1b	1/2 1b	-	0.7 \pm 0.2
1/4 1b	0.25%	-	1/16 1b	1/2 1b	1/2 1b	0.8 \pm 0.3
1/4 1b	0.25%	-	1/16 1b	1/2 1b	1 1b	1.3 \pm 0.7
1/4 1b	0.25%	-	1/16 1b	1/2 1b	2 1b	1.1 \pm 0.4

*Amount is active material per acre except for X-77 which is percent by volume of the total spray mixture.

Table 44. Effect of Garlon-4 concentration on fall growth of bluegrass treated with an Embark-Telar-Surfactant-2,4-D combination. Application was on September 9 with evaluations on September 14, 1987. Initial mowed height of 2 inches prior to spraying.

<u>Embark</u>	<u>Amount*</u>				<u>Bluegrass growth, inches</u>	
	<u>X-77</u>	<u>Telar</u>	<u>Garlon-4</u>	<u>2,4-D</u>	<u>Sept 14</u>	<u>Sept 23</u>
-	-	-	-	-	1.3 \pm 0.3	2.0 \pm 0.3
1/4 lb	0.25%	1/8 oz	-	-	0.3 \pm 0.3	0.2 \pm 0.1
1/4 lb	0.25%	1/8 oz	-	2 lb	0.5 \pm 0.3	0.5 \pm 0.3
1/4 lb	0.25%	1/8 oz	1/4 lb	-	0.3 \pm 0.2	0.5 \pm 0.2
1/4 lb	0.25%	1/8 oz	1/4 lb	2 lb	0.5 \pm 0.4	1.2 \pm 0.3
1/4 lb	0.25%	1/8 oz	1/2 lb	-	0.3 \pm 0.2	0.7 \pm 0.4
1/4 lb	0.25%	1/8 oz	1/2 lb	2 lb	0.4 \pm 0.3	1.0 \pm 0.2
1/4 lb	0.25%	1/8 oz	1 lb	-	0.4 \pm 0.3	1.0 \pm 0.1
1/4 lb	0.25%	1/8 oz	1 lb	2 lb	0.7 \pm 0.4	1.3 \pm 0.2

* Amounts are as active material per acre except for X-77 which is percent by volume of the total spray mixture.

Table 45. Antagonism between Garlon-4 and 2,4-D in the mixture with Embark, surfactant, and 2,4-D. Applied September 10, 1987. Initial mowed height at time of spraying was 2 inches. The combination contained no Telar. Evaluation was on September 23, 1986.

<u>Embark</u>	<u>Amount*</u>			<u>Bluegrass growth, inches</u>
	<u>X-77</u>	<u>Garlon-4</u>	<u>2,4-D</u>	
-	-	-	-	1.4 \pm 0.5
1/2 lb	0.25%	-	-	0.5 \pm 0.4
1/2 lb	0.25%	-	2 lb	0.6 \pm 0.2
1/2 lb	0.25%	1/2 lb	-	0.5 \pm 0.6
1/2 lb	0.25%	1/2 lb	2 lb	0.7 \pm 0.4
1/2 lb	0.25%	1 lb	-	0.3 \pm 0.3
1/2 lb	0.25%	1 lb	2 lb	1.0 \pm 0.5

Table 46. Antagonism between 2,4-D and Fluroxypyr (Starane) in the combination with Embark, Surfactant and Telar. Application on September 16, 1987. Evaluations on October 8, 1987. Initial mowed grass height was 2.5 inches.

Amount*					<u>Bluegrass growth, inches</u>
<u>Embark</u>	<u>X-77</u>	<u>Telar</u>	<u>Fluoroxypyr</u>	<u>2,4-D</u>	
-	-	-	-	-	2.7 \pm 0.2
1/4 lb	0.25%	1/8 oz	-	-	0.2 \pm 0.2
1/4 lb	0.25%	1/8 oz	1/2 lb	-	0.3 \pm 0.1
1/4 lb	0.25%	1/8 oz	1/2 lb	1/2 lb	0.6 \pm 0.1
1/4 lb	0.25%	1/8 oz	1/2 lb	1 lb	0.9 \pm 0.3
1/4 lb	0.25%	1/8 oz	1/2 lb	2 lb	1.2 \pm 0.3

* Amount is active material per acre except for X-77 which was percent by volume of the total spray mixture.

Table 47. Effect of experimental material PNPAC in the presence or absence of 2,4-D on fall growth of bluegrass. Treatments were applied in ethanol compared to ethanol alone on September 17, 1987. Evaluations were on October 8, 1987. Initial mowed grass height was 3 inches.

<u>X-77</u>	<u>Amount*</u>		<u>Grass growth, inches**</u>
	<u>PNPAC</u>	<u>2,4-D</u>	
0.25%	-	-	2.3 \pm 0.3
0.25%	4 lb	-	1.4 \pm 0.4
0.25%	4 lb	2 lb	1.1 \pm 0.1
0.25%	6 lb	-	0.9 \pm 0.2
0.25%	6 lb	2 lb	0.9 \pm 0.2
0.25%	8 lb	-	0.5 \pm 0.0
0.25%	8 lb	2 lb	0.6 \pm 0.1

** \pm standard deviation. Growth in the absence of ethanol was 2.5 \pm 0.0 inches.

Table 48. Effect of experimental materials on fall growth of bluegrass. Treatments were applied on September 23 with evaluations on October 12, 1987. Applications were in ethanol. Initial mowed grass height was 2 inches.

<u>X-77</u>	<u>PNPAC</u>	<u>Amount*</u>		<u>Bluegrass growth, inches**</u>
		<u>4'-nitroacetanilide</u>	<u>Methyl-4-nitro benzene sulfonate</u>	
0.25%	-	-	-	1.3 \pm 0.5
0.25%	8 lb	-	-	1.0 \pm 0.0
0.25%	-	8 lb	-	0.6 \pm 0.2
0.25%	-	-	8 lb	1.3 \pm 0.3

** \pm standard deviation. Growth in the absence of ethanol was 1.5 \pm 0.5 inches.

* Amounts are active materials per acre except for X-77 surfactant which is percent by volume of the total spray mixture.

Acknowledgments

Appreciation is extended to Robert Varnold and Andrew Brightman, graduate students who assisted with the plot work at times and contributed substantially to the laboratory studies that underlie the many new combinations of materials described in this report. John Burkhardt and Dan Zay, IDOH, contributed substantially to the planning and implementation. Specific input from Steve Hom, FHWA representative to the advisory committee, was provided as well. Implementation studies were capably applied with direction and input in planning from Don Bickle, Crawfordsville District. Evaluations of test areas treated by Clyde Mason, Greenfield, also were of considerable importance to the studies reported. Participation of Monsanto, Dow, Ilanco and 3-M agricultural chemical companies and their representatives in the planning and application of specific tests is gratefully acknowledged.

The assistance and thoughtful guidance of Prof. Harold L. Michael, Director, JHRP, Purdue University is much appreciated as is the technical assistance of Mrs. Dorothy Werderitsh.

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